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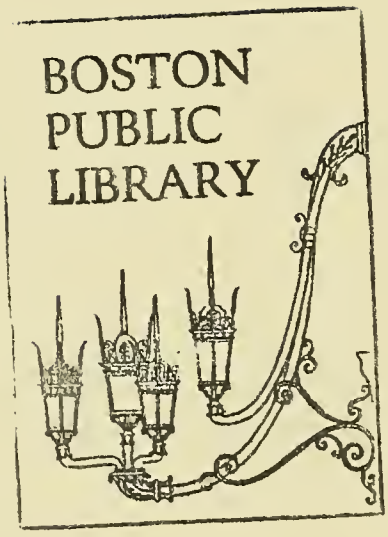
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TRANSPORTATION MASTER PLAN

Brigham and Women's Hospital
Boston, Massachusetts

Vanasse Hangen Brustlin, Inc.

April 1989

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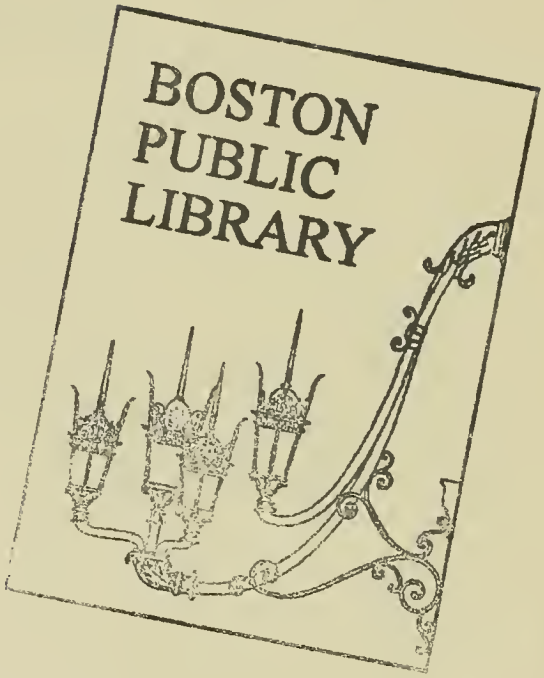
TRANSPORTATION MASTER PLAN
BRIGHAM AND WOMEN'S HOSPITAL



April 1989

Prepared by

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SUMMARY

The Brigham and Women's Hospital (BWH) Transportation Master Plan, prepared in conjunction with its Institutional Master Plan, describes the existing transportation, parking, and pedestrian systems, future parking needs, and proposed demand management and traffic mitigation strategies.

A. TRAFFIC CONDITIONS

The hospital is located in the Longwood Medical Area (LMA) of Boston, adjacent to the Mission Hill neighborhood. Primary access to the hospital is provided by Francis Street with two access points to parking and drop-off centers, one at the main hospital entrance (West Plaza) and the other at the Ambulatory Services (ASB II) Garage. The section of Francis Street adjacent to the hospital's main entrance carries about 10,700 vehicles per weekday. Morning peak hour volumes are lower than afternoon and evening peak hour volumes since the morning peak volume is composed primarily of commuter traffic, while the afternoon and evening peak volumes include patients and visitors as well as commuters.

Traffic volumes along Francis Street are quite stable between the hours of 1:00 PM and 6:00 PM on a typical weekday. Francis Street volumes are not especially high relative to capacity, but congestion exists due to turning vehicles, on-street parking, pedestrian crossings, and unsignalized intersections.

B. HOSPITAL PROFILE

The hospital employs about 5,400 people and has about 2,850 physician affiliates. Registered nurses are the largest group and comprise 30 percent of the hospital employees, followed by clerical employees, who comprise 22 percent. Only 73 percent of

the staff (6,010 employees and physicians) work at the hospital on a typical weekday. (This is the sum of all shifts.) Tenant and contractor employees, patients, and visitors are another 4,054 persons, which brings the total number of daily weekday hospital users to about 10,060 persons.

As of March 1989, the staff parking supply controlled by BWH was 2,304 spaces. (The staff parking supply was 2,074 in November 1988 when the transportation surveys were conducted.) The primary source of staff parking supply is the Mission Park Garage with a capacity of 1,525 spaces. Parking for patients and visitors is provided in the ASB II Garage at 45 Francis Street below the hospital's ambulatory services building. This facility has 240 spaces including 15 handicap spaces.

C. TRANSPORTATION SURVEY RESULTS

Transportation patterns were identified from a series of questionnaire and interview surveys. The overall response rate was 25 percent, with a slightly higher rate (31 percent) for the staff. The survey results for morning (7:30 to 9:59) mode of arrival indicate that 38 percent of the staff commute by public transportation, 49 percent travel by automobile (with an average of 1.3 persons per vehicle), and almost 13 percent walk to work.

The current parking demand was also estimated from the survey results. The estimated peak staff parking demand (2,424 vehicles at 3:00 PM) exceeded the staff parking capacity at the time of the survey by about 350 spaces. The current (March 1989) staff parking supply (2,304 spaces) is just 120 spaces shy of the demand estimated from the survey. Most of the excess demand is likely served at non-BWH garages. The peak patient and visitor parking demand (442 vehicles at 11:00 AM) exceeds the supply at

the ASB II Garage by about 200 vehicles. This apparent deficit is not a problem since the actual vehicle accumulation as counted in the garage showed an underutilization of the parking supply.

Public transportation usage was also estimated based upon the survey results. The data show that usage of the system by BWH users amounts to 6 percent of the system capacity serving the area.

D. PEDESTRIAN ACTIVITY

As might be expected, pedestrian volumes are heavy crossing Francis Street during two peaks in the day, morning and mid-afternoon. These high volumes, however, are not sustained over the course of the day since they consist mainly of employees traveling to and from the Mission Park Garage.

An origin-destination survey was conducted near the ASB II entrance to measure the amount of pedestrian cut-through traffic. Of 117 trips surveyed between noon and 4:00 PM, 102 trips began or ended at BWH, while 15 traveled through the hospital to other destinations.

E. FUTURE GROWTH

The hospital's ten-year development plan results in a population growth of about 9 percent from 10,064 to 10,963 over the same time period. The largest component of the increase is expected to be patients at 16 percent. Physicians and employee categories are expected to increase by 10 percent and 7 percent, respectively.

Based on the forecast growth in hospital services, the peak staff parking demand is expected to increase by 7 percent (from 2,424 to 2,599). Due to additional parking supply, the staff parking deficit is estimated at 283, compared with 350 at the time of the survey in November 1988. The patient and visitor peak parking demand is expected to increase by 10 percent (approximately 44 vehicles). Complete elimination of the staff parking deficit is not desirable because the parking shortage encourages the use of alternative travel modes.

F. RECOMMENDED MANAGEMENT AND MITIGATION PLAN

There are two components to this plan: demand reduction strategies and traffic operations improvements. The demand reduction strategies are targeted toward staff parking levels and include:

- Increased parking fees
- Preferential parking for vanpools and carpools
- Transit subsidies for employees
- Promotion of ridesharing
- Alternative work schedules

Recommended traffic operations improvements include the addition of police control at the intersection of Francis Street and Vining Street during peak hours to facilitate the safe crossing of pedestrians while maintaining acceptable vehicular flow. Signalization is not warranted according to federal guidelines. Other improvements, designed to address areawide traffic flow deficiencies, are presented in the Longwood Medical Area Transportation Study, a comprehensive study completed in 1988 by the Medical Area Service Corporation (MASCO) and Vanasse Hangen Brustlin, Inc. (VHB), and funded by BWH and the other MASCO member institutions.

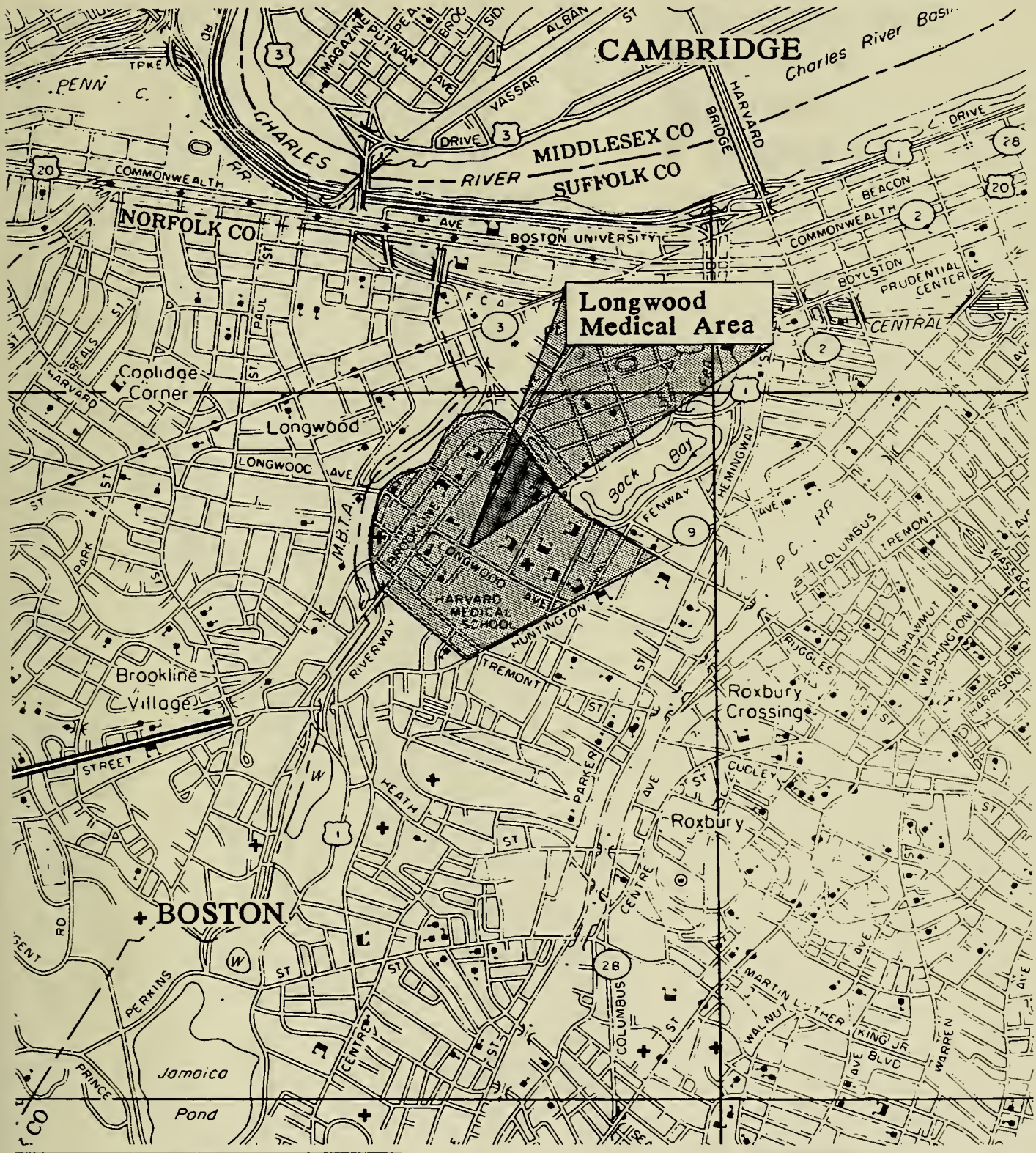
INTRODUCTION

The Brigham and Women's Hospital (BWH) is located in the Longwood Medical Area of Boston, as shown in Figure 1. Figure 2 presents the hospital's main campus and the Boston Lying-In complex (Longwood Avenue and Avenue Louis Pasteur). The primary access to the main campus is via Francis Street. Other roadways serving the area include Huntington Avenue, Brookline Avenue, and Longwood Avenue.

This Transportation Master Plan has been prepared for the Brigham and Women's Hospital in conjunction with the Institutional Master Plan prepared in late 1988. The Institutional Master Plan has projected the hospital development program over a ten-year period. This program was used to project hospital growth and parking demand over the same ten-year period.

The main issues addressed in this report include:

- Characteristics of hospital user groups (employees, physicians, patients, and visitors)
- Travel patterns of these user groups
- Traffic characteristics in the immediate hospital vicinity
- Parking supply, accumulation, and demand
- Characteristics and usage of public transportation
- Pedestrian volumes and circulation
- Impact of projected growth



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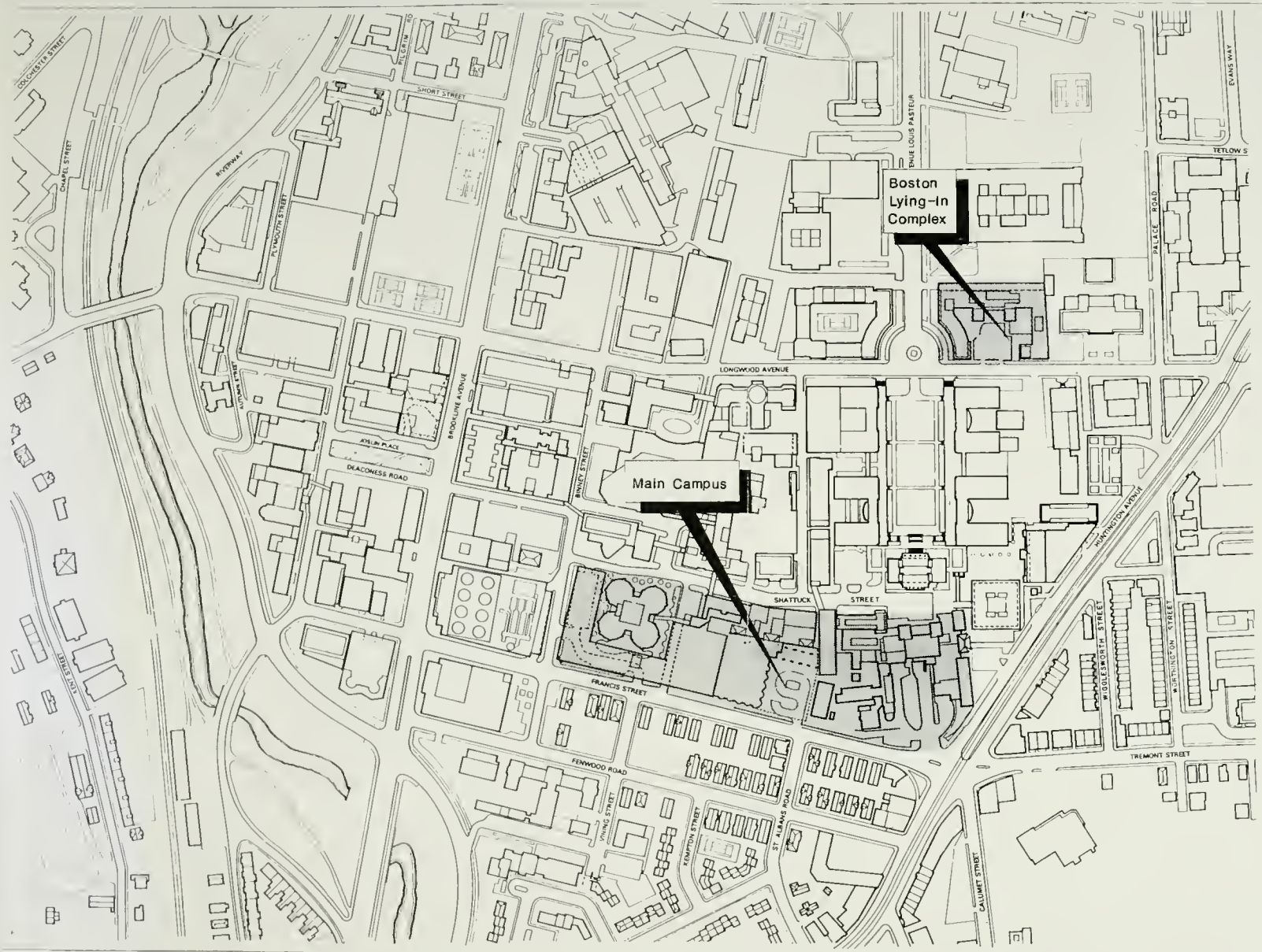
Longwood Medical Area

Fig. 1



Brigham and Women's Hospital Campus

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Fig. 2

- Demand reduction and mitigation strategies

The primary mechanism used to identify current travel patterns was the survey of hospital users conducted in early November, 1988. In addition, vehicle and pedestrian counts were made as were vehicle occupancy counts and garage parking accumulation counts. BWH provided extensive information on staffing levels, parking characteristics, and shipping and receiving policies. The analysis results are presented in the following sections.

A. TRANSPORTATION SURVEY

A survey of hospital users (employees, physicians, patients, and visitors) was conducted on Thursday, November 3, 1988, to identify the travel patterns of these groups including the following:

- Place of residence
- Mode Split
- Time of arrival
- Length of stay
- Parking location

1. Methodology

Two questionnaires were prepared, one for staff (employees and physicians) and the other for patients and visitors. The questionnaire was prepared and distributed in three languages (English, Spanish, and French). All surveys were self-administered, except the patient-visitor survey, which was administered by Vanasse Hangen Brustlin (VHB) staff in the hospital elevator lobby area between 1:00 PM and 8:00 PM on Thursday, November 3, and again on Thursday, November 10, 1988.

Employee questionnaires were distributed with payroll checks on November 3. Physician questionnaires were mailed directly through the hospital mailroom using labels provided by the Office of Medical Staff Affairs. Patient questionnaires were distributed to locations of major out-patient activity as well as the admitting desk for in-patients.

2. Hospital User Profile

An integral part of making projections of future hospital usage is the determination of current hospital usage. The hospital profile or composition of staff, patients, and visitors makes up this usage. In addition, survey returns must be weighted according to the number of persons present, by group, at the hospital on a typical day. Therefore, the number of persons in the individual user groups were identified and are discussed below.

• Employees and Physicians[1]

Total employee and physician staff levels as well as staffing levels on a typical weekday are presented in Table 1. A total of 5,399 employees are on the BWH payroll but, on a typical day only 4,303 are present at BWH.

The Registered Nurse category is the largest group, with 1,637 persons, followed by the secretary and clerical category with 1,189 persons. About 2,850 physicians are affiliated, in some way, with the hospital. The largest individual group is the Active Staff composing approximately 27 percent of the total with 729 persons. Residents make up the second largest individual group with 460 persons.

---

1 A separate survey questionnaire was distributed to employees and physicians at the hospital. This group, collectively, is referred to as staff. The term "employee", as used in this report, excludes physicians.

TABLE 1
HOSPITAL STAFF PROFILE

Category	Total Staff	Staffing on Typical Day
Physicians		
Active Staff	729	365
Fellows*	542	488
Researcher**	284	268
Resident	460	345
Other***	827	241
Sub-Total	2,842	1,707
Employees		
Management	432	390
Registered Nurses	1,637	1,117
Licensed Practical Nurses	69	69
Non-Health Care Prof.	166	150
Health Care Prof.	133	106
Technicians	730	504
Patient Care Assistant	142	109
Research Assistant	260	234
Secretary and Clerical	1,189	1,067
Craft Worker	91	67
Support Services	550	490
Sub-Total	5,399	4,303
Total Staff	8,241	6,010

* Includes Research Fellows, Clinical Fellows and Research and Clinical Fellows.
** Includes Researchers in the Thorn Building.
*** Includes Consultant, Active Emeritus, Associate, and Courtesy. (Inactive Emeritus were not surveyed.)

- **Patients**

For the purpose of this study, the patient category was separated into two groups, in-patient and out-patient (including ambulatory services, clinics, emergency, and physician's offices). Hospital staff indicated that there are about 95 in-

patient admissions on a typical day, of which one-third are obstetrics patients. There are also about 1,700 out-patients visiting the various clinics, physicians offices, or undergoing ambulatory procedures. The emergency room, which is included in the outpatient count, has about 100 patient visits per day.

The hours of operation for all ambulatory services except the emergency room are 9:00 AM to 5:00 PM, Monday through Friday. Hospital staff also indicated that Tuesdays and Thursdays are generally busier days for ambulatory services and, for this reason, the survey was conducted on Thursday, November 3, 1989.

- Patient-Visitors

Patient-visitors were counted at the patient tower lobby on two Thursdays in November between 1:00 PM and 8:00 PM, in conjunction with the patient-visitor survey. Generally, two groups of people enter the elevators in the patient tower, Hospital Staff and visitors. Since hospital staff wear identification badges it was possible to distinguish the visitors. This time period was determined to be the peak period based upon hospital door counts conducted in May 1988 by the hospital security staff. The hourly breakdown of visitor data collected is presented in Table 2. The total two day average for the 1:00 PM to 8:00 PM time period is 1,360 persons. On both days, the greatest hourly volume of entering visitors occurred between 6:00 and 7:00 PM. This volume was 316 on November 3, and 236 on November 10. Generally, the hourly patient-visitor volume is lower in the morning than in the afternoon on a typical weekday. The typical volume of morning patient-visitors (8:00 AM to 1:00 PM) is about one-fourth of the 12-hour volume (8:00 AM to 8:00 PM) of patient-visitors. Based upon this information, the estimated number of patient-visitors between 8:00 AM and 8:00 PM is 1,840 persons.

TABLE 2
BRIGHAM AND WOMEN'S HOSPITAL
OBSERVED PATIENT-VISITOR VOLUMES*
1:00 PM TO 8:00 PM

Time Period	November 3, 1988	November 10, 1988
1:00-2:00 PM	172	169
2:00-3:00	218	162
3:00-4:00	115	176
4:00-5:00	168	120
5:00-6:00	212	124
6:00-7:00	316	236
7:00-8:00	313	219
TOTAL	1,514	1,206

* Total number of patient-visitors entering hospital elevator lobby area.

- Contract Employees

Contract employees are those persons (other than physicians) who regularly work at the hospital but are not on the hospital payroll. They include:

-- Security personnel
-- Construction Contractors
-- Workers at eating establishments (Pat's Place and Au Bon Pain)

The breakdown of contract employees at the hospital on a typical day by group is presented in Table 3.

TABLE 3
CONTRACT EMPLOYEES PRESENT ON A TYPICAL DAY

Category	Number
Security	45
Contractors	50
Pat's Place	17
Au Bon Pain	7
TOTAL	119

This represents about 1 percent of all persons using the hospital on a typical day including employees, physicians, patients, and visitors.

- Business Visitors

The business visitor category was subdivided to provide characteristics for job applicants, who number about 40 per day, and other business visitors, who were estimated at about 260 per day. The number of other business visitors include salespersons, consultants, etc. who visit the hospital was estimated from data provided in the Children's Hospital Master Plan[2] by relating the number of visitors to the number of beds. Both groups were included in the survey of hospital users, however, only the data from the job applicants are usable due to a very low response rate from the other business visitor category.

3. Survey Response Rates

Questionnaires were returned either through hospital mail or the U.S. Postal Service. Approximately 8,100 survey questionnaires were distributed to hospital staff and a return rate of

2Parking Master Plan Study, Children's Medical Center, Boston, Massachusetts, Vanasse Hangen Brustlin, Inc., June, 1988.

31 percent was realized. Table 4 presents a summary of the survey returns by employee and physician category as well as for the other hospital users surveyed. Overall, 25 percent of the hospital users responded to the survey.

Responses to specific questions such as mode split, parking location and time of arrival were subsequently weighted by employee and physician job category as appropriate to determine mode split and parking demand. Actual survey results are presented in later sections of this report.

B. TRAVEL PATTERNS

The previous section presented the number of various hospital users in each of the user categories which are present at the hospital on a typical weekday. This section describes the travel patterns of these same groups. Specifically, the mode split or means of travel to work are presented. Possible modes include:

- Car (which parked in the area including those which park and take the MASCO shuttle)
- Car (drop-off)
- Public transportation (including the MASCO bus from Cambridge)
- Bicycle
- Walk

TABLE 4
SUMMARY OF TRANSPORTATION SURVEY RETURNS

Category	Number Present On A Typical Weekday	Valid Responses	Percent Surveyed
Physicians			
Active Staff	365	283	78
Fellows*	488	132	27
Researcher**	268	135	50
Resident	345	38	11
Other***	241	45	19
Sub-Total	1,707	633	37
Employees			
Management	390	181	46
Registered Nurse	1,117	347	31
Licensed Practical Nurse	69	23	33
Non-health Care Professional	150	74	49
Health Care Professional	106	83	78
Technicians	504	134	27
PCA, Orderly	109	12	11
Research Assistant	234	62	27
Secretary/Clerical	1,067	252	24
Craft Workers	67	10	15
Support Services	490	23	5
Sub-Total	4,303	1,201	28
Non-BWH Employees+	119	61	51
Patients			
In-Patient	95	70	74
Out-Patient	1,700++	318	19
Sub-Total	1,795	388	22
Visitors			
Patient Visitors	1,840+++	181	10
Job Applicants	40	25	63
Business Visitors	260	0	0
Sub-Total	2,140	206	10
TOTAL	10,064	2,489	25

* Includes Research Fellows, Clinical Fellows and Research and Clinical Fellows.
** Includes researchers in the Thorn Building.
*** Includes Consultant, Emeritus (Active), Associate, Courtesy. (Inactive Emeritus were not surveyed)
\+ Includes contractors, Thorn building employees, Au Bon Pain, Pat's Place, Security Personnel.
++ Estimated by Ambulatory Services Department Staff.
+++ Twelve-hour estimated visitor volume (8:00 AM to 8:00 PM time period).

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Table 5 presents the daily mode split for each category of hospital user. Overall, about 69 percent of the hospital users (physicians, employees, patients, and visitors) commute by auto[3] while about 22 percent take some form of public transportation, and 9 percent walk. These daily percentages include all shifts (day, evening and night).

Employees overall had about 63 percent auto trips. Categories such as Registered Nurses, which have a high percentage of persons arriving at the hospital during non-traditional commuting hours correspondingly have a high percentage of auto trips (88 percent). Groups such as secretary and clerical, however, which work more traditional hours, have a much smaller percentage of auto trips (53 percent). The vehicle occupancy rate for employees, representing the level of ridesharing, was 1.24 persons per vehicle over the course of the day.

Overall, physicians had about 13 percent walking trips and about 67 percent auto trips. Within the group, Fellows had the highest percentage by public transportation (26 percent). More than 90 percent of the active staff physicians traveled by auto. The vehicle occupancy rate over the course of the day for physicians (1.20) was lower than that of employees.

Sixty-seven percent of patients drove or were dropped off. Another 23 percent took public transportation. These persons were primarily out-patients. As might be expected, about 94 percent of all in-patients drove or were driven to the hospital.

While most visitors (81 percent) traveled by auto, most job applicants (within the visitor category) either took public transportation or walked (72 percent).

3Auto users include drivers, passengers, and a few taxi cab customers.

TABLE 5
HOSPITAL USERS MODE OF ARRIVAL
TYPICAL WEEKDAY

Category	Number of Persons Arriving+	Percentage by Mode				
		Car Parked*	Dropped** Off	Public Trans***	Bike	Walk
Physicians						
Active Staff	365	91.0	1.4	2.6	2.5	2.5
Fellows	488	41.2	5.3	26.0	11.5	16.0
Researcher	268	55.0	2.9	21.5	3.9	16.7
Resident	345	57.8	2.6	13.2	5.3	21.1
Other	241	87.0	4.4	4.3	0.0	4.3
Subtotal	1,707	63.8	3.4	14.7	5.5	12.6
Employees						
Management	390	69.1	3.3	18.8	0.0	8.8
Reg. Nurse	1,117	84.4	3.2	9.2	0.6	2.6
Licensed Prac. Nurse	69	63.7	13.6	22.7	0.0	0.0
Non-Health Care Prof.	150	53.9	4.1	33.9	0.0	8.1
Health Care Prof.	106	58.7	5.0	28.8	1.2	6.3
Technician	504	51.3	3.0	35.8	2.2	7.7
PCA/Ord.	109	41.7	8.3	33.3	0.0	16.7
Research Ass.	234	41.7	1.6	46.7	1.6	8.4
Sec/Clerical	1,067	43.3	9.3	39.3	0.0	8.1
Craft	67	70.0	0.0	30.0	0.0	0.0
Support	490	43.5	0.0	39.1	0.0	17.4
Subtotal	4,303	58.6	4.6	28.6	0.5	7.7
Contract Employees	119	59.2	6.5	24.5	0.0	9.8
Patients						
In-Patients	95	71.6	22.8	4.2	0.0	1.4
Out-Patients	1,700	59.2	6.5	24.5	0.0	9.8
	1,795	59.8	7.4	23.4	0.0	9.4
Visitors						
Patient Visitors	1,840	77.2	5.0	11.7	0.0	6.1
Job Applicants	40	24.0	4.0	44.0	0.0	28.0
Business	260	75.0	5.0	5.0	0.0	15.0
	2,140	75.9	5.0	11.5	0.0	7.6
TOTAL	10,064					
Weighted Avg.		63.5	5.0	21.6	1.1	8.8

* Includes remote lots with MASCO shuttle.
** Includes taxi.
*** Includes MASCO bus from Cambridge.
\+ Number of persons arriving on a typical weekday estimated by Hospital staff.

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While it is appropriate to review daily patterns of arrival to the hospital, it is also relevant to review data for the 7:30 AM to 9:59 AM period, which coincides with the day shift arrivals.

Table 6 presents the mode of arrival for the morning (7:30 to 9:59) period. The percentage of staff commuting by auto is just 49 percent. The vehicle occupancy rate for staff (employees and physicians) is 1.30 persons per vehicle. The distribution is 1.39 persons per vehicle for employees and 1.17 persons per vehicle for physicians. The physician occupancy rate is expected to be lower since there is not as great an opportunity for car-pooling. As might also be expected, employee public transportation usage is higher during the traditional morning commuter period (about 38 percent compared with about 29 percent daily). Walking trips account for almost 13 percent of all employee commuter trips. This can be attributed to the location of the hospital, which is on the border of the Mission Hill residential community.

C. TRAFFIC CONDITIONS

Current traffic conditions were evaluated for the study area which included Francis Street from Brookline Avenue to Huntington Avenue. Specifically, the following tasks were conducted:

- Observation of vehicular and pedestrian activity
- Automatic traffic recorder counts
- Manual turning movement and classification counts
- Vehicle occupancy counts
- Pedestrian origin and destination survey

The findings of the evaluation are presented below.

TABLE 6
HOSPITAL STAFF
MODE OF ARRIVAL
(7:30 AM TO 9:59 AM)

Category	Number of Persons Arriving+	Percentage by Mode				
		Car Parked*	Dropped** Off	Public Trans***	Bike	Walk
Physicians						
Active Staff	202	88.3	0.7	4.5	3.9	2.6
Fellows	379	35.4	6.1	30.2	12.1	16.2
Researcher	121	51.1	1.2	25.7	4.9	17.1
Resident	144	53.2	0.0	20.1	6.7	20.0
Other	129	86.5	4.5	4.5	0.0	4.5
Subtotal	975	57.7	3.3	19.4	7.1	12.5
Employees						
Management	244	60.7	2.7	25.0	0.0	11.6
Reg. Nurse	171	71.1	3.8	19.2	0.0	5.9
Licensed Prac. Nurse	19	33.3	0.0	66.7	0.0	0.0
Non-Health Care Prof.	109	47.2	3.8	37.7	0.0	11.3
Health Care Prof.	61	51.9	6.8	32.3	2.2	6.8
Technician	301	42.2	3.9	38.2	3.9	11.8
PCA/Ord.	50	40.0	0.0	20.0	0.0	40.0
Research Ass.	184	38.7	0.0	52.6	0.0	8.7
Sec/Clerical	715	39.5	10.0	41.7	0.0	8.8
Craft	27	50.0	0.0	50.0	0.0	0.0
Support	156	14.2	0.0	42.9	0.0	42.9
Subtotal	2,037	44.0	5.1	37.7	0.6	12.7
Total	3,012					
Weighted Avg.		48.4	4.5	31.8	2.7	12.6

* Includes remote lots with MASCO shuttle.
** Includes taxi.
*** Includes MASCO bus from Cambridge.
\+ Number of persons arriving between 7:30 AM and 10:00 AM as estimated from the survey data.

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1. Roadway Network

Francis Street is a two-lane collector road providing primary access to the main campus via the West Plaza and the ASB II drop-off area. Huntington Avenue which provides the eastern border of the study area is a four-lane arterial with average weekday daily traffic volume of 26,440 vehicles. Brookline Avenue, which borders the study area on the west, is a four-lane arterial with an average weekday daily traffic volume of about 28,300 vehicles.

2. Traffic Observations

General observations of traffic operations in the area were conducted concurrent with the vehicular counts and on other field visits to the Hospital area. These observations are summarized below by location.

• Francis Street, Vining Street, and BWH Main Entrance

Although traffic volumes are not especially high relative to the roadway capacity, this intersection is frequently congested during the morning peak hours and throughout the afternoon. The main deficiencies are noted below:

-- Taxi cabs make illegal movements (including U-turns) to reach the taxi stand on the north side of Francis Street just east of the intersection creating a hazardous situation for other drivers and pedestrians.

-- Each driver entering the driveway is questioned by a security guard. When several vehicles enter within a short time, the queue can extend back from the security guard through the intersection.

-- Conflicts between vehicular and pedestrian movements cause delay and confusion for both drivers and pedestrians.

- Francis Street, ASB II Garage, and St. Albans Street

Ambulances and chair cars (used to transport wheelchair patients) park in the drop-off area at the ASB II entrance to the hospital. Sometimes four or five vehicles are parked for periods as long as 30 minutes. When the queue of the parked vehicles extends back to the entrance of the parking garage, conflicts between turning vehicles arise as maneuverability is restricted by the parked vehicles.

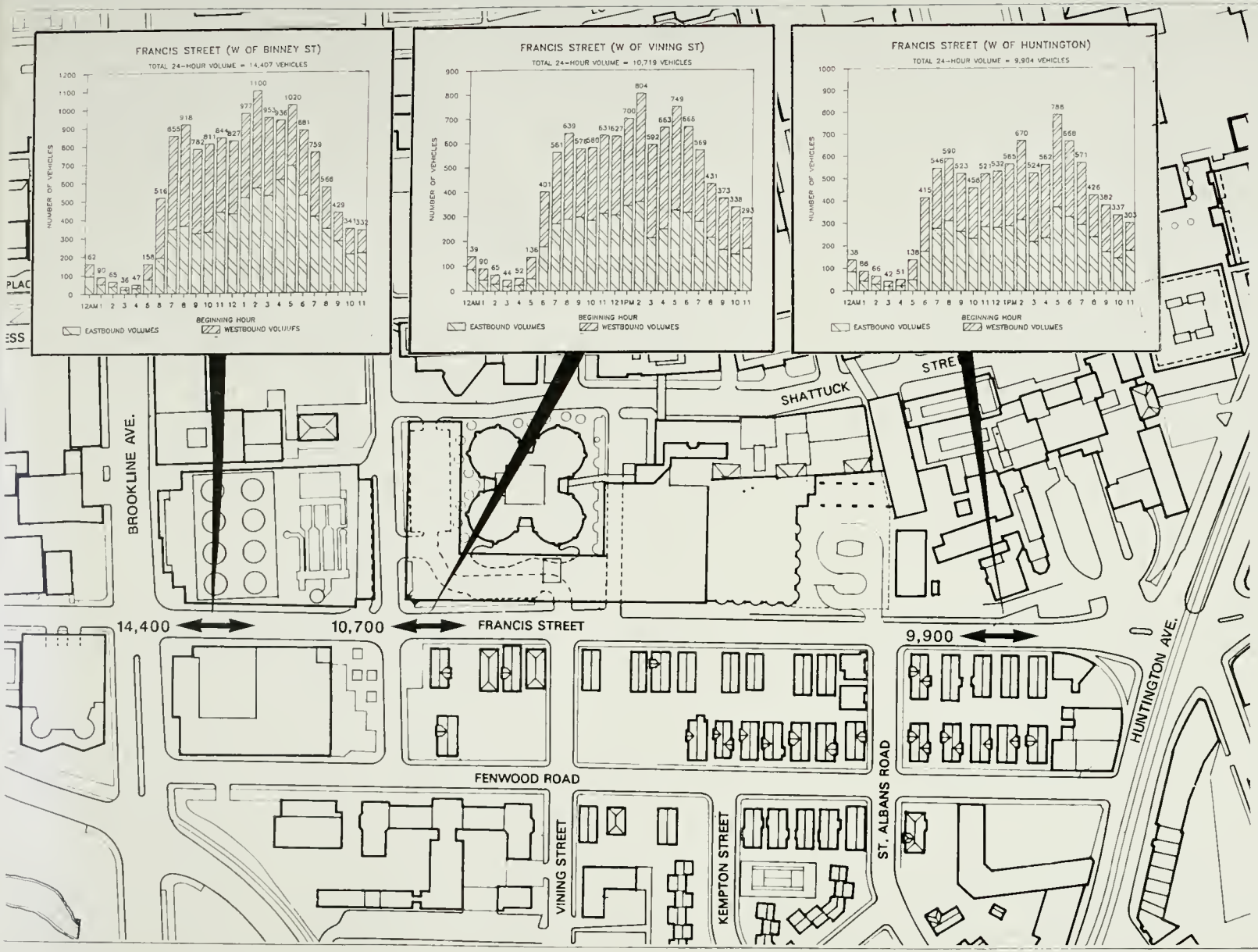
3. Traffic Counts

Measurements of the 24-hour traffic volumes along Francis Street were made during the week of November 14, 1988. Automatic traffic recorders were placed at three locations on Francis Street:

- Just west of Binney Street
- Just east of Binney Street
- Between St. Albans Road and Huntington Avenue

A manual turning movement count was also conducted at the Francis Street, Vining Street, and BWH Main Entrance intersection on Thursday, November 3, 1988, from 7:00 AM to 10:00 AM and from 11:00 AM to 5:30 PM.

The 24-hour profiles are presented in Figure 3. The daily volumes along Francis Street range from 9,900 near Huntington Avenue to 14,400 near Brookline Avenue. The section between Vining Street and Binney Street carries approximately 10,700 vehicles per day.



Temporal Distribution of Traffic Volumes Francis Street

NOTE:
Automatic traffic recorder counts were conducted during the week of November 14, 1989

LEGEND:
↔ Vehicles Per Day

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Not to Scale

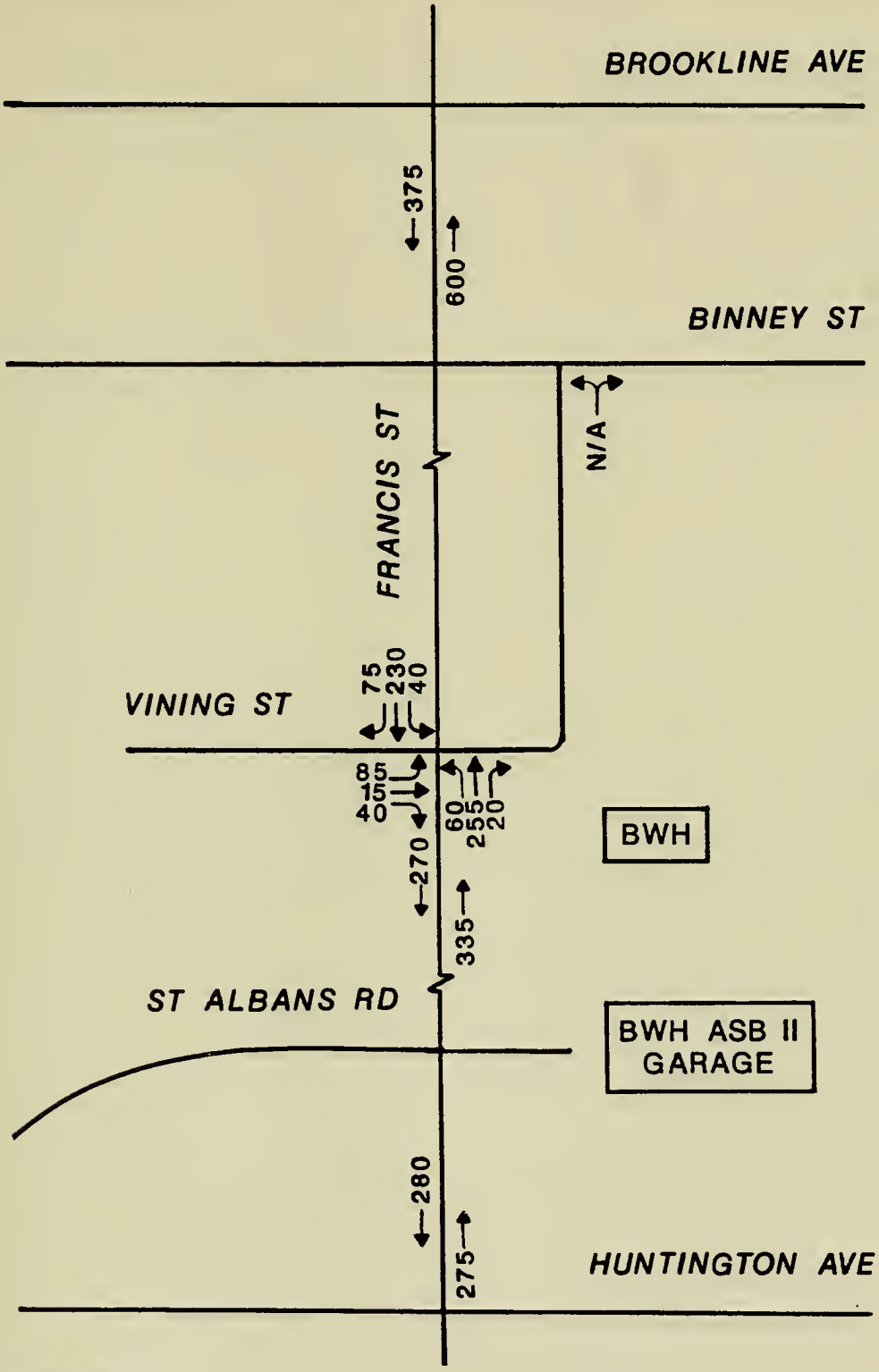
Fig. 3

Examination of these data and the manual count data from the intersection, identified three distinct peak periods (7:45 to 8:45 AM; 2:00 to 3:00 PM; and, 5:00 to 6:00 PM). Francis Street provides access to the hospital and the Mission Park Garage, which contribute to the peaking characteristics of the area. In addition to the traditional commuter peak hours in the morning and early evening, there is a mid-afternoon peak hour, which coincides with the change in hospital shifts (primarily nurses).

The morning peak hour (7:45 to 8:45) volumes for Francis Street and the intersection are presented in Figure 4. As shown, the two-way volume on Francis Street is greatest near Brookline Avenue with 975 vehicles. The mid-afternoon peak (2:00 PM to 3:00 PM), volumes on Francis Street are the highest of the three peak hours (indicated by the 1,100 vehicles on the same section) as shown in Figure 5. During the evening peak hour (5:00 to 6:00 PM), volumes along Francis Street are slightly lower than the afternoon peak hour (1,060 vehicles vs. 1,100 vehicles).

The evening peak hour volumes for Vining Street are presented in Figure 6. This peak hour generally extends from 5:00 to 6:00. However, the volume on Vining Street peaks between 3:30 and 4:30 PM, coincident with the departure of day shift workers. Further, it should be noted that the movements oriented to the Hospital peak earlier (3:00 to 4:00).

Traffic volumes along Francis Street between the hours of 1:00 PM and 6:00 PM do not fluctuate significantly. The existence of medical facilities (including BWH) in this area has a major effect on the distribution of traffic volumes over the course of a typical weekday and contributes to the stable traffic level during the afternoon hours.



Note: N/A=Not Available

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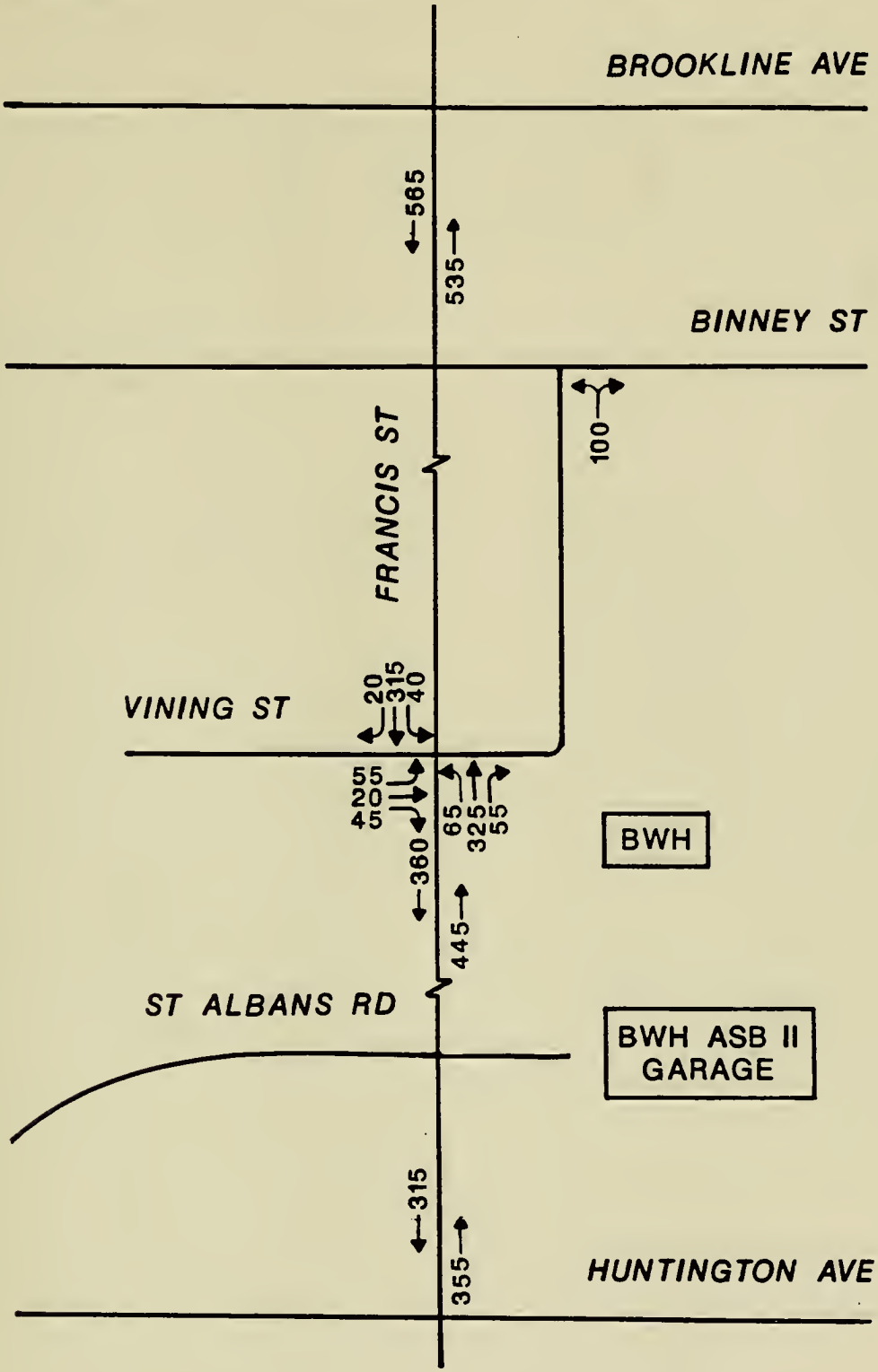
AM Peak Hour (7:45–8:45 AM) Traffic Volumes

Not to Scale

Fig. 4



Midday Peak Hour
(2:00–3:00 PM)
Traffic Volumes

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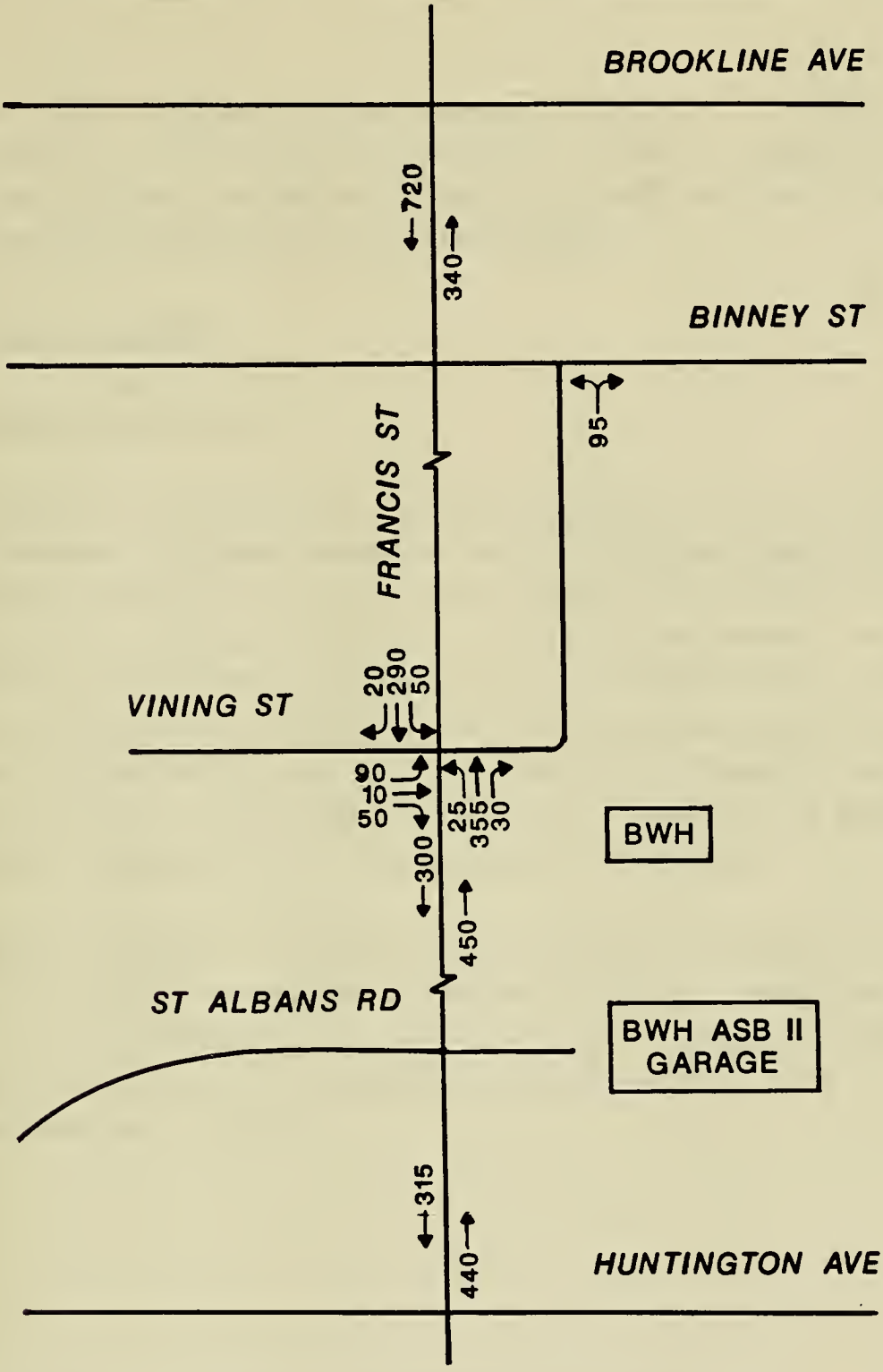
Not to Scale

Fig. 5



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Not to Scale

PM Peak Hour Traffic Volumes

Fig. 6

The traffic volumes along Francis Street are not especially high relative to the street's capacity. However, congestion and delay result from turning vehicles, on-street parking, pedestrian crossings, and unsignalized intersections.

4. Level of Service

• Analysis Procedures

Signalized intersections within the study area were evaluated using computer programs based on the 1985 Highway Capacity Manual[4] procedures. Signalized intersection analysis considers a wide variety of prevailing conditions, including the amount and distribution of traffic movements, traffic composition, geometric characteristics, and the details of intersection signalization. Critical to the evaluation are the concepts of capacity and level of service (LOS), which must be considered together to evaluate the overall operation of a signalized intersection.

A major concept in signalized intersection analysis is level of service, which is defined in terms of delay. Specifically, level of service delay criteria are stated in average stopped delay per vehicle for a 15-minute analysis period. The criteria are represented in Table 7.

4 Transportation Research Board, Special Report 209, Highway Capacity Manual, Washington, D.C., 1985.

TABLE 7
LEVEL OF SERVICE DELAY CRITERIA

Level of Service	Stopped Delay per Vehicle (sec
A	≤5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	>60.0

- Results

The two signalized intersections on Francis Street at Brookline Avenue and Huntington Avenue have been studied previously as part of the Longwood Medical Area (LMA) Transportation Study. During the time which has elapsed between the LMA Transportation Study and this study, little has changed which would affect the operations of the two intersections. Therefore the levels of service, volume-to-capacity ratios, and delays given in that report are presented again in Table 8.

As shown in Table 8, the intersection of Brookline Avenue and Francis Street was calculated as operating at capacity (v/c = 1.01), but the overall intersection level of service is C during the morning peak hour. This indicates that the v/c ratios are over capacity for certain movements (in this case, the left turn into Francis Street eastbound from Brookline Avenue southbound and the left turn out of Francis Street westbound to Brookline Avenue southbound), and the intersection as a whole is processing as much volume as possible, but that the average delay incurred by drivers is acceptable.

TABLE 8*
LEVELS OF SERVICE
SIGNALIZED INTERSECTIONS

	V/C**	Delay (Sec.)	LOS***
Francis Street and Brookline Avenue			
Morning Peak Hour	1.01	17	C
Evening Peak Hour	0.81	20	C
Francis Street and Huntington Avenue			
Morning Peak Hour	0.76	24	C
Evening Peak Hour	0.94	58	E

* Longwood Medical Area Transportation Study - Technical Memorandum No. 1, Vanasse Hangen Brustlin, Inc., May, 1988.
** Volume-to-capacity ratio.
*** Level of service.

The intersection of Francis Street and Huntington Avenue is approaching capacity during the evening peak hour (v/c = 0.94). The overall delay is 58 seconds.

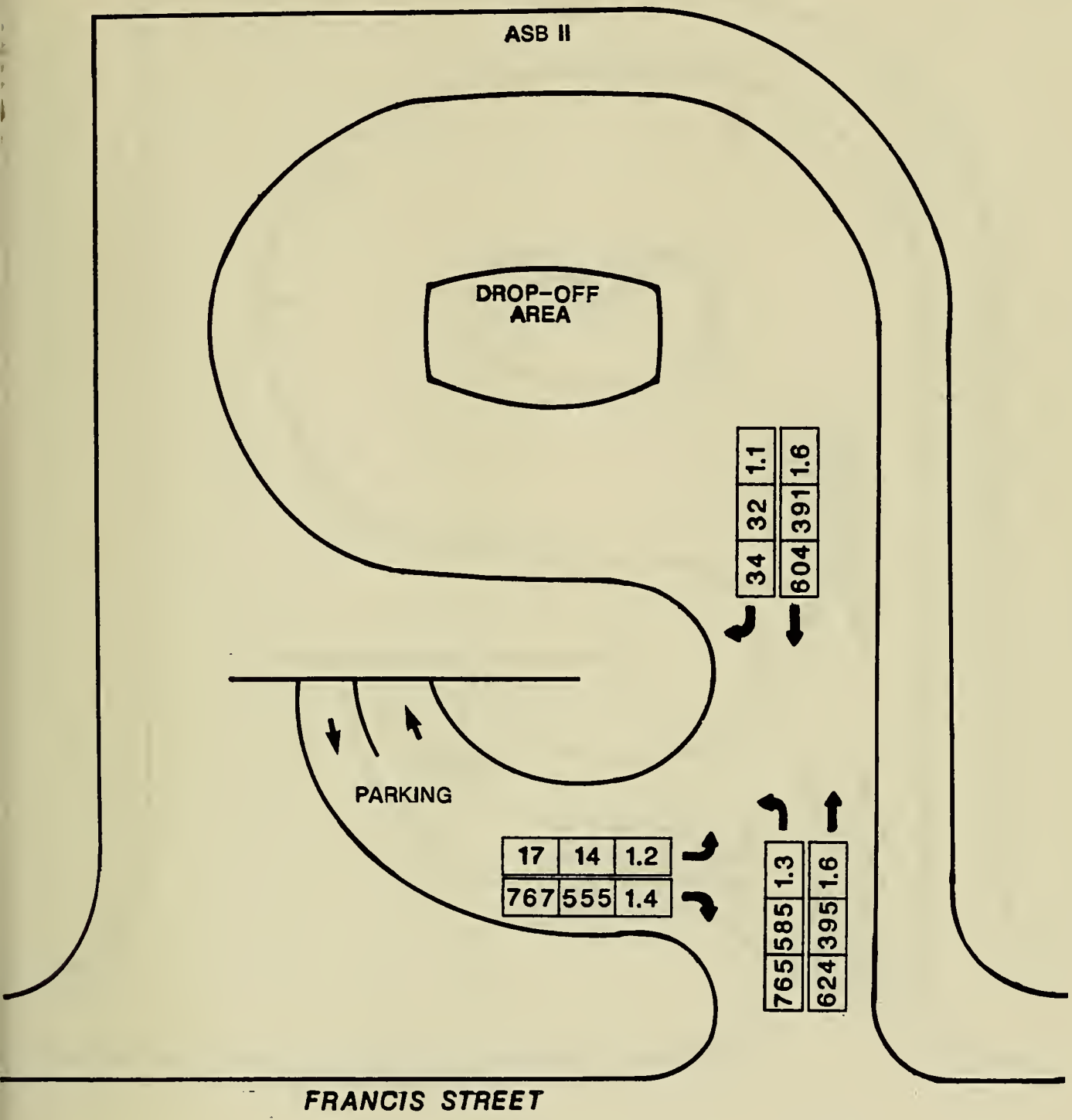
5. Vehicle Occupancy Counts

The Ambulatory Services Building (ASB) II Garage is accessed through an entrance shared by the drop-off area. Those persons wishing to enter the garage from Francis Street simply make a left turn directly down to the attendant booth. Those persons wishing to drop-off or pick-up passengers would continue straight from Francis Street to the drop-off area. The garage is easily accessible by those who have dropped off passengers, by driving around the loop and turning right into the garage. (See Figure 7 for a conceptual sketch of the access location).

A vehicle occupancy count was conducted at the ASB II Garage entrance and drop-off area. This count included only the occupancy of passenger cars although total vehicle traffic entering the area was counted and classified. The purpose of this count was to verify the results of the patient survey as well as to obtain first hand data regarding auto occupancy and usage of the drop-off area. Figure 7 presents the results of the data collected on November 10, 1988, between 8:00 AM and 5:30 PM. As shown in the figure, 585 vehicles entered and either dropped off or picked up passengers. Those vehicles which entered the garage directly had an average vehicle occupancy of 1.3 persons. A similar number of vehicles (555) with a vehicle occupancy of 1.4 persons per vehicle departed the garage during the same time period. The vehicle occupancy of greater than one indicates that not all drivers drop off their passengers prior to entering the garage. Similar trends are evident as shown in Figures 8 and 9 for the midday and evening peak hours, respectively.

Figure 10 presents the percentage of vehicles which are multi-occupant on movements entering and exiting the garage. As shown, 196 vehicles or 35 percent of the total that exit the garage between 8:00 AM and 5:30 PM are multi-occupant. Twenty-six (26) percent of those vehicles entering the garage directly are multi-occupant, and as expected, only two percent of those vehicles passing through the drop-off area and entering the garage are multi-occupant.

An additional observation can be made from the data regarding drivers who drop off their passengers prior to entering the garage at the ASB II. Review of the data shows that of all drivers arriving at ASB II with passengers and intending to park, 16 percent drop off their passengers in the loop area prior to entering the garage, while 84 percent proceed directly to the garage. When drivers with passengers leave ASB II, only six



LEGEND:

P	V	VOR

P= Passengers
V= Vehicles
VOR= Vehicle Occupancy Rate

Total Vehicles (8:00 AM–5:30 PM)

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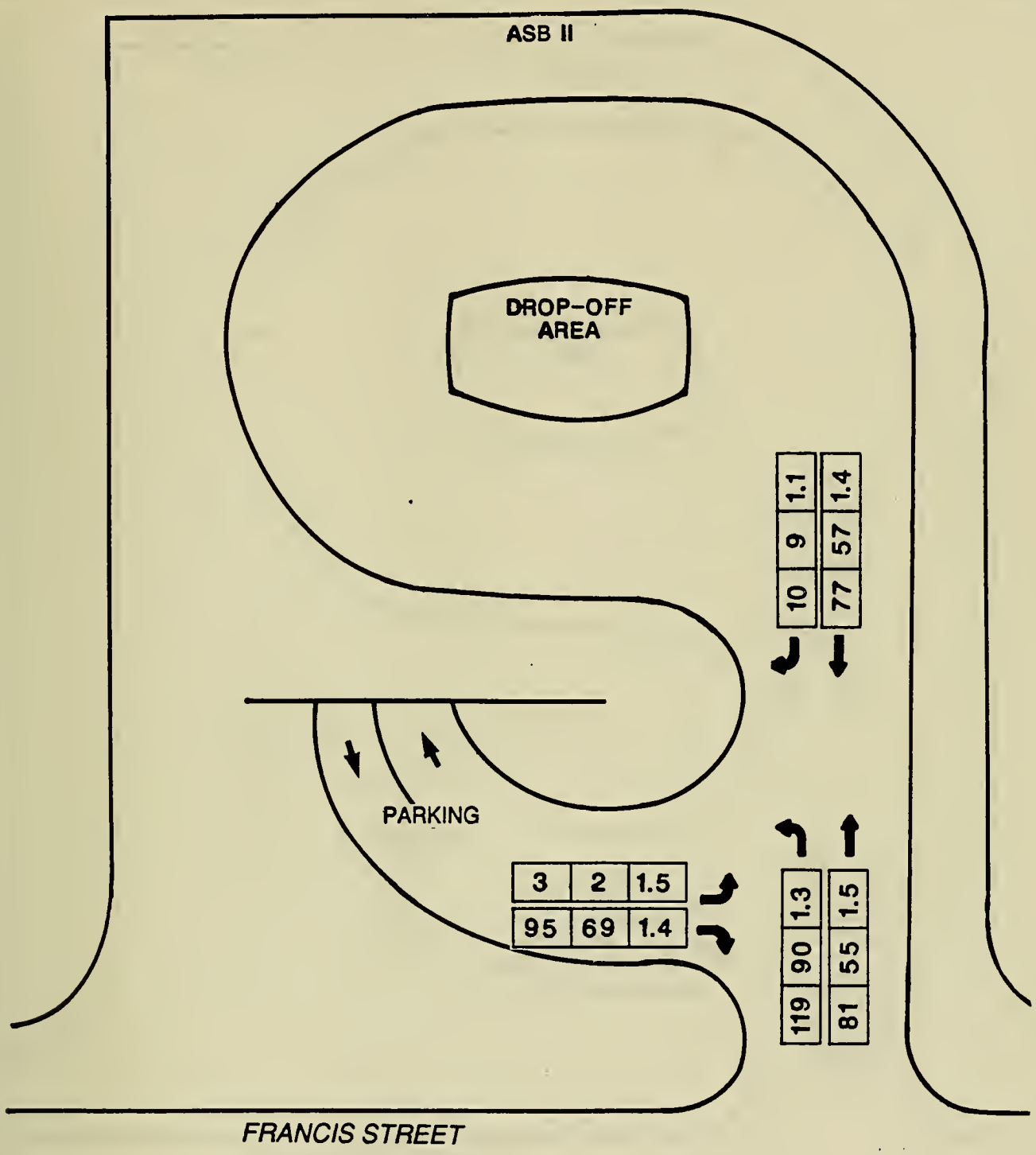
Not to Scale

Fig. 7



Total Vehicles Midday Peak Hour (1:00–2:00PM)

LEGEND:

P	V	VOR

P= Passengers
V= Vehicles
VOR= Vehicle Occupancy Rate

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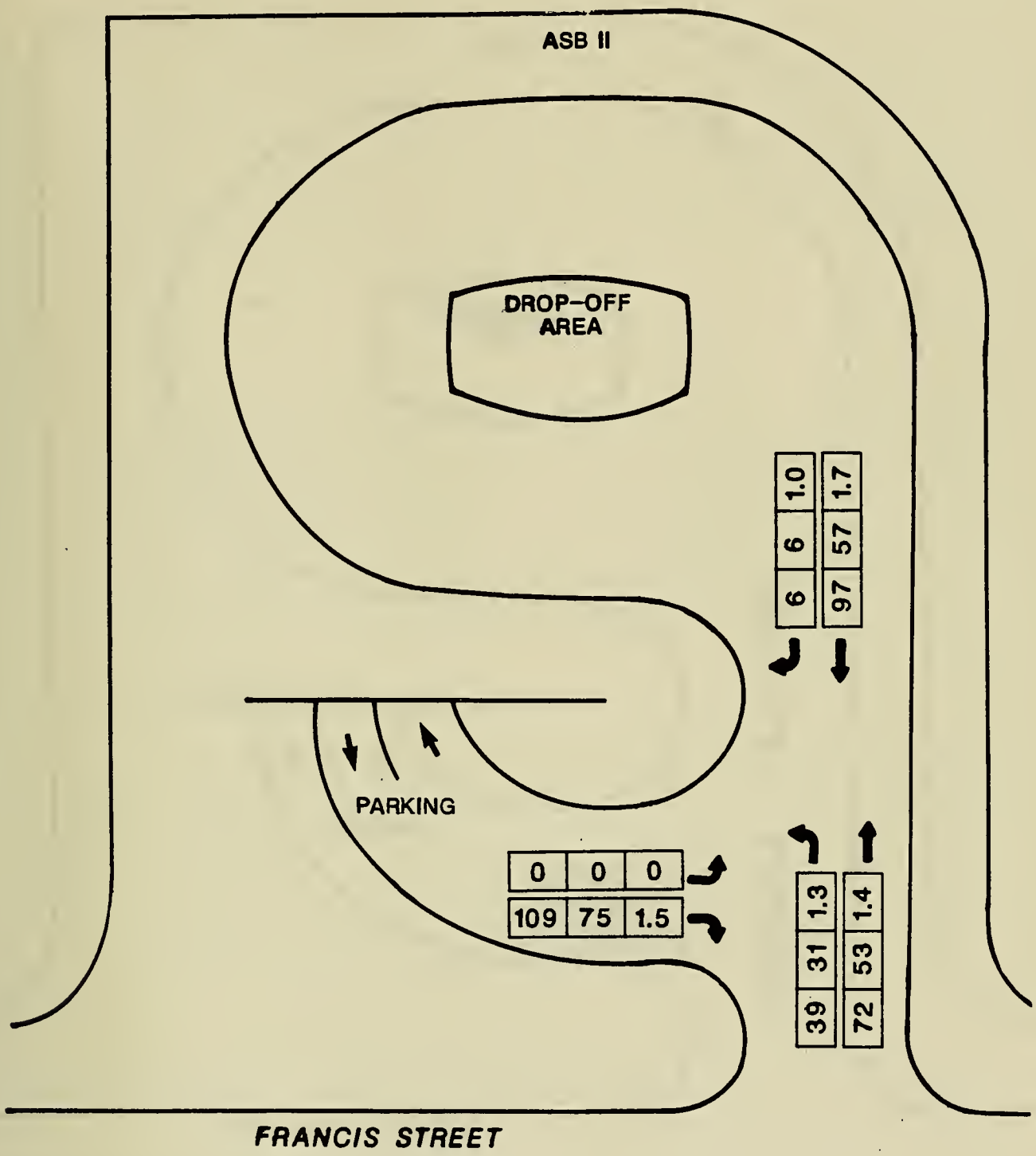
Fig. 8



LEGEND:

P	V	VOR

P= Passengers
V= Vehicles
VOR= Vehicle Occupancy Rate

Total Vehicles PM Peak Hour (4:00–5:00 PM)

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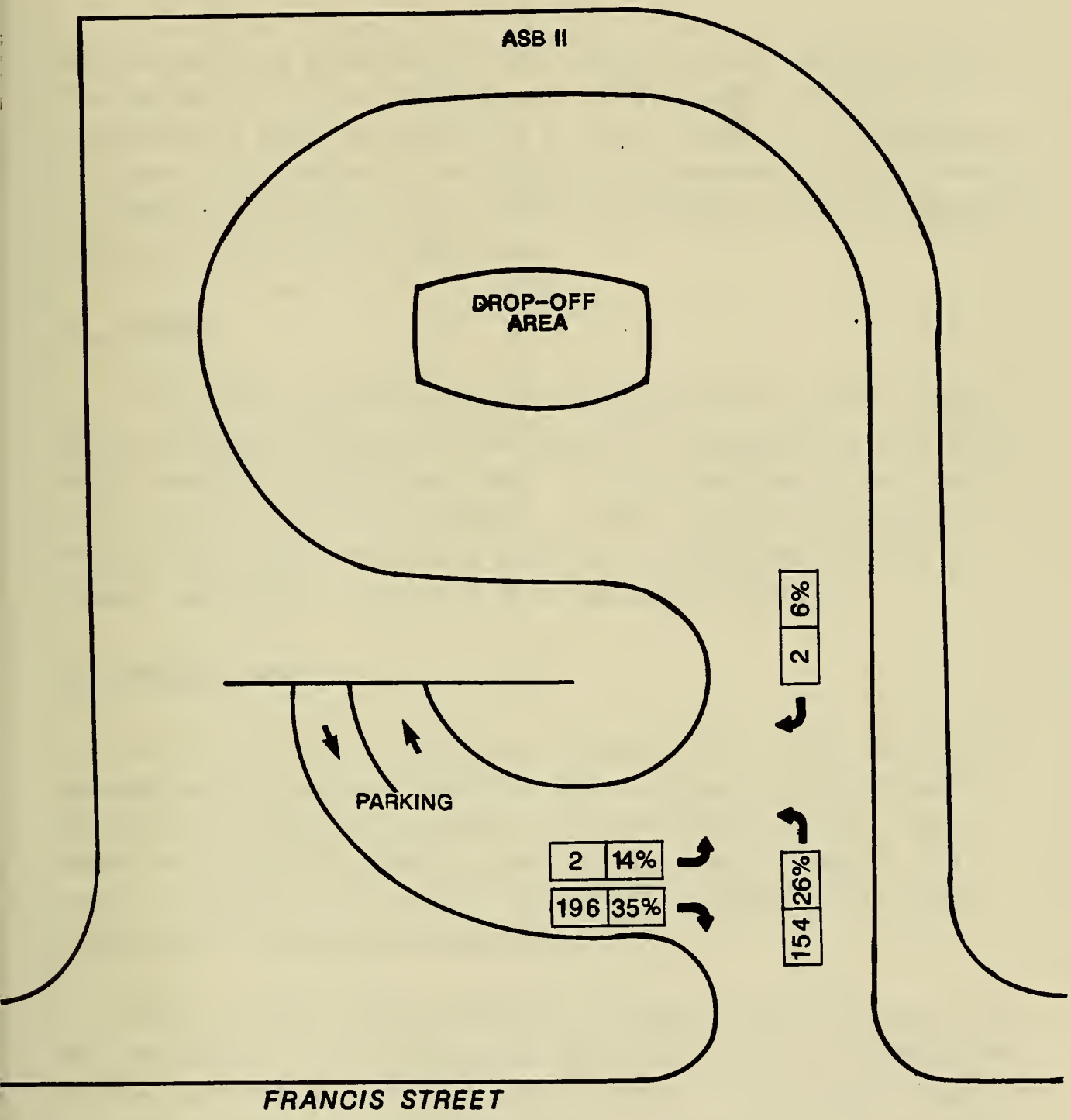
Not to Scale

Fig. 9



Multiple Occupant Vehicles (8:00AM–5:30PM)

LEGEND:

MOV | %

MOV= Multiple Occupant Vehicles
%= Percent of Total Vehicles

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Not to Scale

Fig. 10

percent pick up passengers in the loop, while 94 percent walk to the garage with their passengers. These numbers confirm our observations that the loop area is used primarily by ambulances, and chair cars (which do not park in the garage) and also that it is equally convenient to get into the hospital from the garage as from the front door at the loop.

D. PARKING

The current (spring 1989) parking situation at BWH is somewhat different from what it was when the transportation surveys were conducted in November 1988. In this section of the report, current statistics (as of March 1, 1989) are presented first. The November 1988 statistics are also provided where these are deemed useful for comparison with the survey results.

1. Parking Supply

As of March 1989, there were approximately 2,290 off-street marked parking spaces currently under the control of BWH and available for use by its staff, patients and visitors. The majority (2,029) of these spaces are reserved for staff. The ASB II Garage has 240 spaces which are available to the public, including 15 designated handicap spaces.

The off-street spaces reserved for staff can be divided into two categories: (1) 1,619 marked spaces within walking distance of the hospital and (2) 410 parking spaces in locations requiring a shuttle bus ride (provided by MASCO) to and from the hospital. Parking facility locations are illustrated in Figure 11. The staff parking facilities with their respective number of marked spaces and permits issued are presented in Table 9-A. The staff parking data existing at the time of the survey are presented in Table 9-B. As shown in both tables, the largest supply of staff

Existing Parking Supply Locations

LEGEND:

1. Service Center Garage
2. Mission Park Garage
3. Peter Bent Brigham
4. Calumet Street Lot
5. Mass. College of Art (Longwood Ave.)
6. Vin/Fen Lot
7. Shattuck Street Lot
8. 49 Landsdowne Street
9. Wentworth
10. West Plaza

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0 150 300
SCALE IN FEET

Fig. 11

parking is in the Mission Park Garage, where approximately 1,250 marked spaces are located. The staff parking is assigned by facility, and key-cards are issued to parkers.

TABLE 9-A
BWH STAFF PARKING FACILITY ASSIGNMENT*
AS OF MARCH 1988

Facility	Number of Marked Spaces	Monthly Permits Issued
1. Servicenter Garage	185	202
2. Mission Park Garage	1,250	1,773
3. Peter Bent Brigham Front	26	14
4. Calumet St. Lot	55	55
5. Mass. College of Art (Longwood Avenue)	20	20
6. Vin/Fen (Vining Street and Fenwood Road)	55	7
7. Shattuck Street	19***	19
8. #49 Landsdowne Street	225	70
9. Wentworth	185	170
10. West Plaza	9	0
TOTAL	2,029	2,330**

* Source: BWH parking office.
** In some of the parking facilities,the number of monthly permits issued exceeds the number of spaces. This is possible because of multiple shifts and because some permit holders are not at BWH on a full-time basis.
*** Remaining spaces are used by staff physicians who are billed for hours parked.

TABLE 9-B
BWH STAFF PARKING FACILITY ASSIGNMENT*
AS OF NOVEMBER 1988

Facility	Number of Marked Spaces	Monthly Permits Issued
1. Servicenter Garage	160	177
2. Mission Park Garage	1,250	1,773
3. Peter Bent Brigham Front	26	9
4. Calumet St. Lot	55	55
5. Mass. College of Art (Longwood Avenue)	20	8
6. Vin/Fen (Vining Street and Fenwood Road)	55	7***
7. Shattuck Street	19+	19
8. Mass. College of Art (Huntington Avenue)	70	33
9. Wentworth	135	170
10. West Plaza	9	0
TOTAL	1,799	2,251**

* Source: BWH parking office.
** In some of the parking facilities,the number of monthly permits issued exceeds the number of spaces. This is possible because of multiple shifts and because some permit holders are not at BWH on a full-time basis.
*** Remaining spaces are used by staff physicians who are billed for hours parked.
\+ There are 21 additional spaces available for contractor and visitor parking on Shattuck Street.

No special preference is given to match the work location or residence location with the closest parking facility. Between 6:00 AM and 10:00 AM, only card-holders are admitted to the Mission Park Garage. During all other times, any employee with a valid hospital I.D. may enter the facility. These facilities are

generally used by day-shift and evening shift employees. Night-shift (11:00 PM to 7:00 AM) employees are encouraged to use the ASB II Garage.

In addition to these two major facilities controlled by the hospital, two other parking areas which the hospital owns should be mentioned: the Vin/Fen Lot and the West Plaza.

The Vin/Fen lot on the corner of Vining Street and Fenwood Road is used primarily by physicians. Only seven monthly parkers are assigned to this location, but 570 people (primarily physicians) have key-cards for this facility and use it on a less regular basis. These individuals are billed for parking at an hourly rate.

The West Plaza area near the hospital main entrance has 49 designated parking spaces mostly available for short-term drop-offs, pick-ups, and deliveries. This area is patrolled by security guards who screen drivers at the entrance and direct them to an appropriate parking space in the West Plaza or elsewhere. The breakdown of these spaces is shown below:

- 30 minute parking - 20 spaces
- Deliveries - 3 spaces
- O.B. Discharge - 5 spaces
- Handicap - 7 spaces
- Reserved Vin/Fen - 8 spaces
- Hospital Use - 1 spaces
- Reserved - 1 spaces
- Public - 4 spaces

2. Parking Rates

The monthly parking rates for the various BWH-controlled staff parking facilities are presented in Tables 10-A and 10-B. The average monthly cost to parkers based upon the number of monthly permit holders was about $73 as of March 1989; it was about $64 when the survey was conducted.

• Mission Park Garage

Staff members who do not hold a key-card for admission to the Mission Park Garage may enter the facility before about 6:00 AM and after 10:00 AM and pay for parking according to the work shift during which they entered the garage. The payment schedule as of March 1989, is shown below (the rates in effect at the time of the survey are shown in parentheses);

- Day shift $3.30 ($2.95)
- Evening shift $3.00 ($2.60)
- Night shift $2.60 ($2.25)

These rates are comparable to those paid by key-card holders on a daily basis.

• ASB II Garage

Spaces in ASB II garage are provided for hospital visitors and intended for short-term parking. As shown below, the rate which one would pay to park all day is $15.00. The complete rate schedule is presented below.

0-1/2 hour	$2.00
1/2-1 hour	$3.00
1-2 hours	$4.00

TABLE 10-A
STAFF PARKING RATE SCHEDULE
AS OF MARCH 1989

Facility	Proxmity to BWH	Number of Assigned Monthly Parkers	Monthly Cost
1. Servicenter Garage (Francis Street)	Nearby	202	$99.00
2. Mission Park Garage (Vining Street)	Nearby	1,773	$72.00
3. Peter Bent Brigham Front	Nearby	14	$99.00
4. Calumet Street Lot	Nearby	55	$91.00
5. Mass. College of Art (Longwood Avenue)	Nearby	20	$91.00
6. Vin/Fen #1 (Vining Street/ Fenwood Avenue)	Nearby	7	$110.00
7. Shattuck Street	Nearby	19	$99.00
8. #49 Landsdowne Street	Remote	70	$45.00
9. Wentworth	Remote	170	$45.00
Total Assigned Monthly Parkers		2,330	
Weighted Average Monthly Cost			$72.67

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TABLE 10-8
STAFF PARKING RATE SCHEDULE
AS OF NOVEMBER 1988

	Facility	Proxmity to BWH	Number of Assigned Monthly Parkers	Monthly Cost
1.	Servicenter Garage (Francis Street)	Nearby	177	$92.00
2.	Mission Park Garage (Vining Street)	Nearby	1,773	$62.00
3.	Peter Bent Brigham Front	Nearby	9	$92.00
4.	Calumet Street Lot	Nearby	55	$85.00
5.	Mass. College of Art (Longwood Avenue)	Nearby	8	$85.00
6.	Vin/Fen #1 (Vining Street and Fenwood Avenue)	Nearby	7	$110.00
7.	Shattuck Street	Nearby	19	$92.00
8.	Mass. College of Art (Huntington Avenue)	Nearby	33	$83.00
9.	Wentworth	Remote	170	$36.00
	Total Assigned Monthly Parkers		2,251	
	Weighted Average Monthly Cost			$63.87

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2-3 hours	$5.00
3-4 hours	$6.00
4-5 hours	$7.00
5-6 hours	$8.00
6-24 hours	$15.00

Hospital staff on the night-shift (11:00 PM to 7:00 AM) are permitted to park in the ASB II Garage at a reduced rate of $1.50 for the length of the shift.

3. Parking Utilization

• Mission Park Garage

Parking utilization counts are conducted on a regular basis by the hospital at the Mission Park Garage. The weekday arrival and departure patterns are relatively consistent over the course of the week. A sample of data presented in Table 11 represents the weekday average for the week of October 31, 1988. Approximately 200 vehicles are in the garage prior to 6:00 AM on an average weekday.[5] Based upon this, the average maximum vehicle accumulation is 1,531 vehicles between 11:00 AM and 12:00 Noon. The garage parking supply as provided by the hospital is 1,250 spaces. Table 11 indicates that peak accumulation (approximately 1,525 vehicles) lasts from noon until 5:00 PM. Hospital parking staff indicated that the parking accumulation drops off significantly after 5:00 PM. Observations made in the Mission Park Garage by VHB staff indicate that the number of vehicles parked in the garage is greater than the number of marked spaces and that there are methods used which would enable the facility to

5 Based upon a count conducted by VHB staff on Friday, December 16, 1988, and confirmed by Mission Park Garage staff as being typical.

accommodate more vehicles than there are spaces marked, including signs posted in the facility which indicate that vehicles will be blocked in if they park in certain areas.

TABLE 11
AVERAGE WEEKDAY VEHICLE ACCUMULATION
MISSION PARK GARAGE

Time Period	Entering	Exiting	Accumulation
at 6:00 AM	-	-	200
6:00- 7:00 AM	293	22	471
7:00- 8:00	469	20	920
8:00- 9:00	333	52	1,201
9:00-10:00	249	36	1,414
10:00-11:00	100	22	1,492
11:00-12:00 Noon	61	22	1,531
12:00- 1:00 PM	32	33	1,530
1:00- 2:00	37	40	1,527
2:00- 3:00	40	41	1,526
3:00- 4:00	49	48	1,527
4:00- 5:00	39	46	1,520

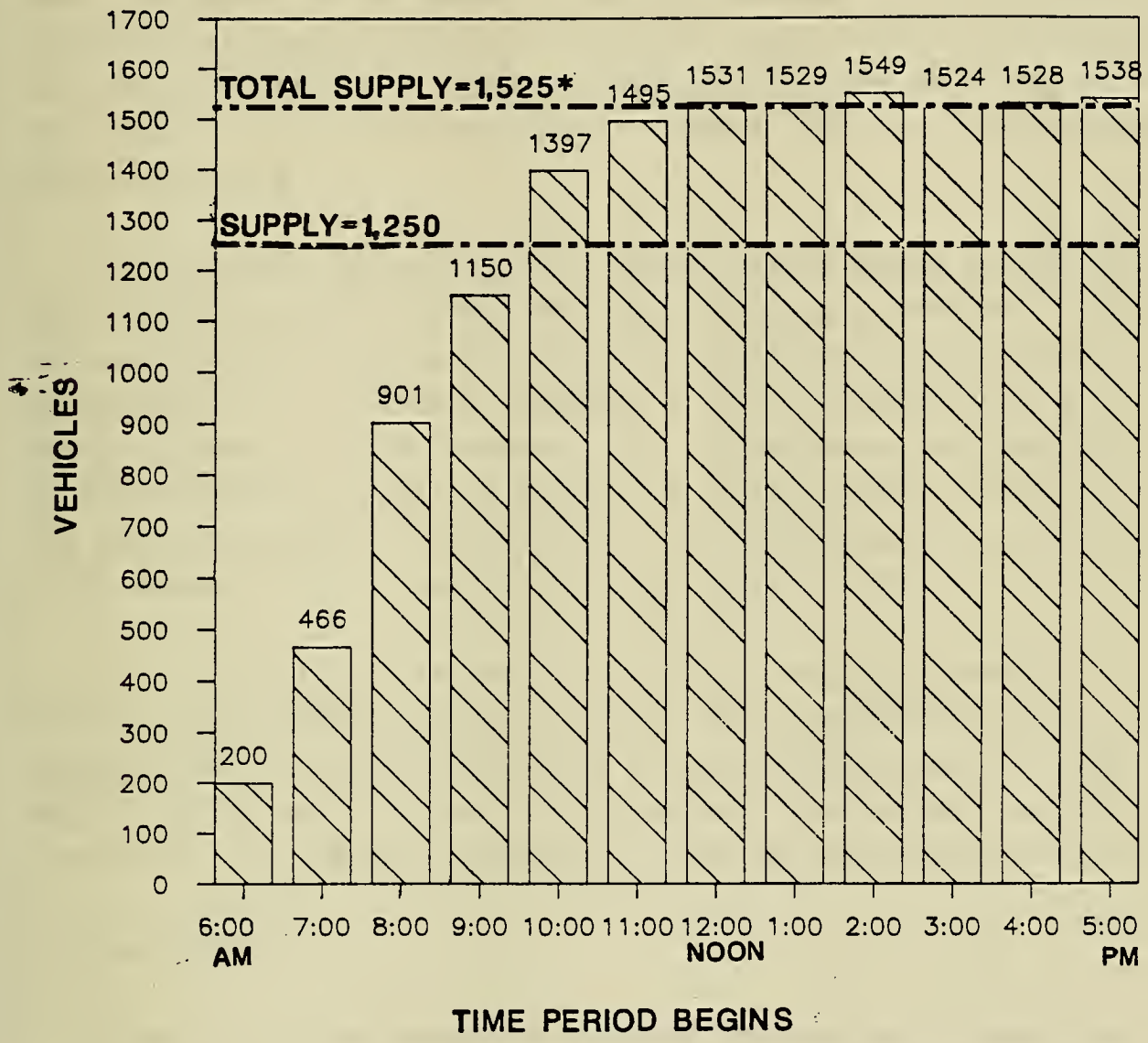
Source: BWH.

The vehicle accumulation for Thursday, November 3, 1988 is presented in Figure 12. A comparison between the Thursday data and the weekday average shows that the patterns are very similar.

Use of this facility over the course of the week is consistent. It is generally used to capacity during the day-shift, with usage decreasing significantly after 5:00 PM.

- ASB II Garage

Parking utilization counts are also conducted on a regular basis at the ASB II Garage. Table 12 presents the average weekday vehicle accumulation for the week of October 31, 1988. The total parking supply in the ASB II Garage is 240 spaces. The volume in the garage begins building at around 7:00 AM, peaks



Vehicle Accumulation Mission Park Garage Thursday, 11/3/88

* Total Supply Includes Unmarked Spaces Being Utilized

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Fig. 12

between 1:00 PM and 2:00 PM (194 vehicles), and begins to taper off in the subsequent hours. The weekday data collected shows a small increase in the number of parkers during the evening hours, probably representing patient visitors. The average total number of vehicles entering the garage during the course of a day is 753, resulting in a turnover rate of about three (3) vehicles per space per day.

The hospital indicated that Tuesday and Thursday are generally busy days due to heavy ambulatory surgery schedules. This is exemplified in Figure 13, which presents the daily vehicle accumulation for Thursday, November 3, 1988. The garage again peaks at about 2:00 PM, however, the accumulation (on Thursday) is approximately 20 percent greater than the weekday average. The peaking patterns are similar to the weekday average, and the total number of vehicles entering the garage is 794.

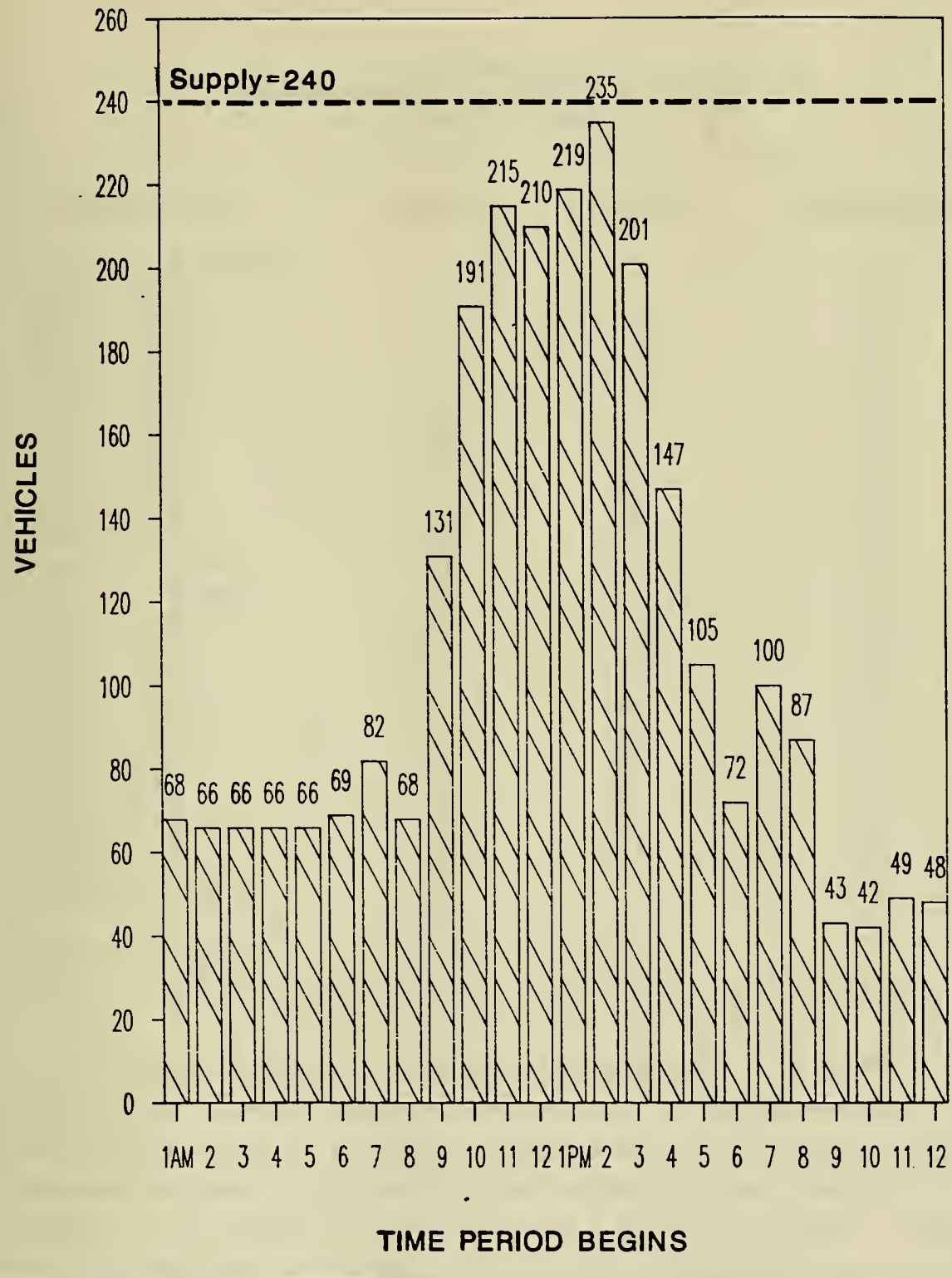
Data provided by the hospital for the week of October 31, 1988, for the ASB II Garage indicated that the demand falls slightly short of the supply even at the two peak hours of the day (11:00 AM and 2:00 PM). This may mean that other, equally convenient, spaces are available for use by the general public.

- **West Plaza**

A parking usage study was conducted at the West Plaza drop-off area on Thursday November 3, 1988. The data collected were tabulated to determine:

- Vehicle accumulation;
- Number of drive-through vehicles; and,
- Length of stay.

This information is presented in Tables 13, 14 and 15 respectively.



Vehicle Accumulation ASB II Garage Thursday, 11/3/88

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Fig. 13

TABLE 12
AVERAGE WEEKDAY VEHICLE ACCUMULATION
ASB II GARAGE

Time Period	Entering	Exiting	Accumulation
12:00 Mid-1:00 AM	1	1	57
1:00- 2:00	1	1	57
2:00- 3:00	1	2	56
3:00- 4:00	0	1	55
4:00- 5:00	0	1	54
5:00- 6:00	1	1	54
6:00- 7:00	19	2	71
7:00- 8:00	29	41	59
8:00- 9:00	70	26	103
9:00-10:00	101	32	172
10:00-11:00	81	60	193
11:00-12:00 Noon	51	72	172
12:00- 1:00 PM	61	67	172
1:00- 2:00	80	58	194
2:00- 3:00	51	82	169
3:00- 4:00	41	80	130
4:00- 5:00	27	64	93
5:00- 6:00	27	50	70
6:00- 7:00	58	27	101
7:00- 8:00	14	33	82
8:00- 9:00	4	32	54
9:00-10:00	3	14	43
10:00-11:00	14	4	53
11:00-12:00 Mid	6	4	55
Total Vehicles	753	755	

As shown in Table 13, during the 8:00 AM to 5:30 PM survey period, the highest vehicle accumulation occurred between 8:00 and 9:00 AM with 45 vehicles. Approximately 846 vehicles passed through the West Plaza during the survey period. Table 14 presents the number of drive-through vehicles by hour. These include vehicles which were in the West Plaza area for fewer than three minutes and likely dropped off or picked up passengers. The busiest time was between 10:00 AM and 11:00 AM. Table 15 is perhaps the most significant in terms of identifying the use of the drop-off area as a short-term facility. Sixty (60) percent

of the total vehicles which entered the West Plaza stayed for fewer than three minutes. Just under half (108) of the 264 vehicles which entered the area and parked, stayed for fewer than ten minutes.

The conclusion drawn from the data collected at the West Plaza is that this area is well patrolled and controlled such that its function, to provide short-term parking for deliveries and such, is achieved. Very few vehicles remained in the facility for more than sixty minutes.

TABLE 13
WEST PLAZA VEHICLE ACCUMULATION

Time Period	Entering Volume	Exiting Volume	Vehicle Accumulation
at 8:00 AM			40
8:00- 9:00	25	20	45
9:00-10:00	21	25	41
10:00-11:00	45	48	38
11:00-12:00 Noon	37	54	21
12:00- 1:00 PM	42	35	28
1:00- 2:00	66	60	34
2:00- 3:00	53	56	31
3:00- 4:00	42	53	20
4:00- 5:00 PM	45	37	28
	376	388	

TABLE 14
WEST PLAZA
NUMBER OF DRIVE-THROUGH VEHICLES*

Time Period	Drive-Through Volume
8:00- 9:00 AM	65
9:00-10:00	59
10:00-11:00	71
11:00-12:00 Noon	69
12:00- 1:00 PM	64
1:00- 2:00	66
2:00- 3:00	59
3:00- 4:00	55
4:00- 5:00	51
5:00- 5:30	23
	582

* Designated as having a duration of fewer than three minutes.

TABLE 15
WEST PLAZA VEHICLE DURATION
(8:00 AM TO 5:30 PM)

Duration (Minutes)	Number of Vehicles	Percentage
0 - 2 minutes	582	69
3 - 9 minutes	108	13
10 - 29 minutes	92	11
30 - 59 minutes	26	3
60 + minutes	38	4
	846	100

4. Parking Demand

Estimates of the parking demand for the two basic segments of the hospital population, staff (employees and physicians) and others (patients and visitors) were derived from the survey responses. The resulting demand for both categories is presented below.

- Staff Parking[6]

The estimated staff parking demand is presented in Figure 14. As shown, the peak demand (approximately 2,424 vehicles) occurs between 2:00 PM and 3:30 PM, which is coincident with the nursing staff shift change. As shown in the figure, the parking demand reaches a stable point at about 10:00 AM which continues until about 2:00 PM when there is a peak in demand, as mentioned above. After 3:30 PM demand declines steadily as staffing levels decline to a stable level for the night shift.

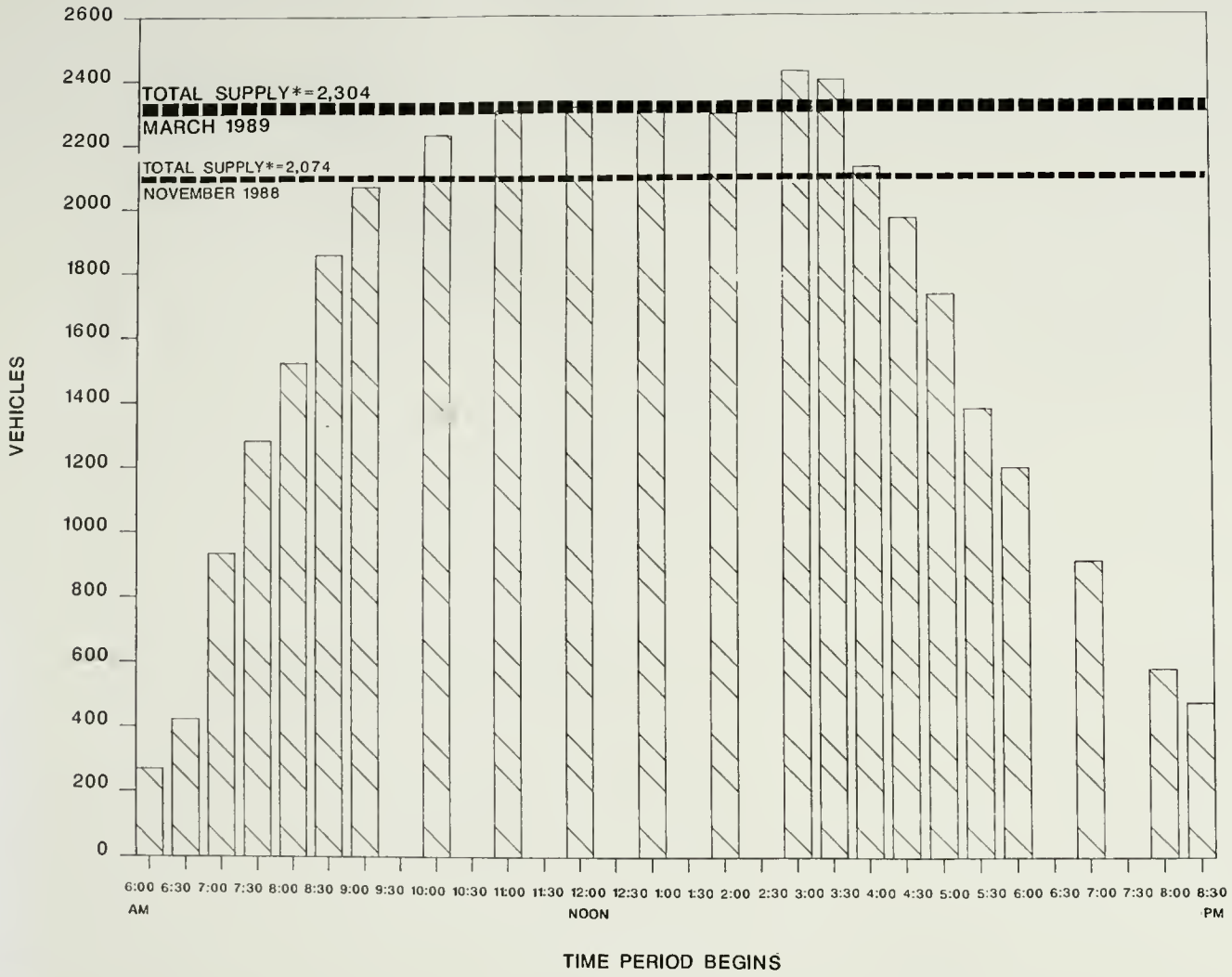
The peak staff parking demand estimated from the survey should be compared with the staff parking supply which existed at the time of the survey in November 1988. While this supply consisted of 1,799 marked spaces, actual accumulation counts at the Mission Park Garage indicated that the number of vehicles which parked in the facility (1,525) exceeded the number of marked spaces (1,250) by about 275. Therefore, the total staff parking supply at the time of the survey was considered to be 2,074, about 350 less than the peak staff parking demand. (Most of these 350 vehicles were likely parked at a parking facility on a cash basis.) As shown in Figure 14, the March 1989 staff parking supply is 2,304 spaces, just 120 spaces less than the peak staff parking demand estimated from the survey.

- Patient and Visitor Parking

Patients and visitors have the opportunity to park at a number of locations, including the ASB II Garage, Servicenter Garage, and on-street. The estimated patient and visitor parking demand is presented in Table 16. As shown, the peak demand is at 11:00 AM with 442 vehicles. This is about 200 vehicles greater

6 Staff includes employees and physicians.

Staff Parking Demand



* Total supply includes unmarked spaces being utilized.

LEGEND:

= Vehicles

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Fig. 14

than the supply provided at the ASB II Garage and Shattuck Street (261 spaces). This apparent parking deficit is not a problem, as demonstrated in the previous section, which presented the actual vehicle accumulation at the ASB II Garage as 193 vehicles during the 11:00 AM peak hour. The data collected actually show an underutilization of the garage. Visitors and patients are likely to park at a location most familiar to them, and the variety of choices in the BWH area provides enough short-term parking spaces to meet the current demand estimated.

- Summary of Current Demand

Table 16 presents the staff and patient and visitor parking demand estimated from the survey as well as the total hospital parking demand. As shown, the peak demand, 2,769 vehicles, occurs at 3:00 PM. The 11:00 AM peak identified independently for patient and visitor demand is quite close in volume to the 3:00 PM hour. The estimated demand exceeds the number of parking spaces under BWH control (2,565 as of March 1989; 2,335 at the time of the survey) from 10:00 AM to 4:00 PM. This, however, is not as critical as it may seem because of the other off-street and on-street parking spaces available in the area.

E. PUBLIC TRANSPORTATION

The Longwood Medical Area (LMA) is served by two branches of the MBTA Green Line and four regular MBTA bus routes. Each of these routes provides service to communities outside the LMA. For day-shift workers who live within walking distance of any of these MBTA routes, mass transit is an alternative for commuting trips.

TABLE 16
ESTIMATED CURRENT HOSPITAL PARKING DEMAND

Time	Demand		
	Staff	Patient and Visitors	Total
6:00 AM	269	N/A	N/A
7:00	933	N/A	N/A
8:00	1,522	84	1,606
9:00	2,068	201	2,269
10:00	2,231	347	2,578
11:00	2,304	442	2,746
12:00 Noon	2,314	412	2,726
1:00 PM	2,302	399	2,701
2:00	2,292	379	2,671
3:00	2,424	345	2,769
4:00	2,126	206	2,332
5:00	1,730	159	1,889
6:00	1,196	114	1,310
7:00	908	242	1,150
8:00	578	340	918
9:00	448	N/A	N/A
12:00 Midnight	216	N/A	N/A

N/A = Not available.

Each branch of the Green Line connects a part of the LMA with the Back Bay and downtown Boston, where connections to other subway lines can be made. The Highland Branch, or Riverside (D) Line, serving Longwood Station at the western fringe of the LMA, runs west through Brookline and Newton to Riverside Station (near the junction of Routes I-90 and I-95), where park-and-ride facilities are provided. The Arborway (E) Line, serving Huntington Avenue along the eastern border of the LMA, runs south through Roxbury and Jamaica Plain to Forest Hills Station, where passengers may transfer to buses serving Dedham, West Roxbury, Hyde Park and Roslindale. Both branches operate seven days a week, from 5:30 AM until after midnight. Service is scheduled at least every 10 minutes during most of those hours.

Due to ongoing road construction on Huntington Avenue in the LMA, Arborway streetcar service south of Brigham Circle has been suspended, and a temporary bus route (#39) runs along the trolley route between Forest Hills Station in Jamaica Plain and Copley Square in the Back Bay. Buses provide the same service hours as the Green Line streetcars did, but with higher frequencies. Buses are scheduled at least every five minutes each weekday from 6:30 AM to 11:00 PM. In addition, light rail vehicles (LRVs) operate in the Huntington Avenue median between Brigham Circle in the LMA and downtown Boston.

Bus Routes 47 and 66 both travel east to Dudley Square and other points in Roxbury. Route 66 serves the LMA chiefly at Brigham Circle, while Route 47 provides more comprehensive coverage of the LMA, serving much of Longwood and Brookline Avenues. Route 66 also runs northwest through Brookline to Allston, while Route 47 travels north through Cambridgeport to Central Square. At Ruggles Station, Route 47 connects with the Orange Line and many Roxbury and Dorchester bus routes. Route 47 was recently extended eastward to meet the Red Line at Andrew Square.

Routes 47 and 66 have similar service hours and frequencies: headways are ten minutes or less during rush hours, about 20 minutes at midday, and about 30 minutes during evenings and weekends. These routes can be used for commuting by second-shift and third-shift workers because service runs past midnight seven days a week. However, the low frequencies make evening travel inconvenient.

MBTA Routes 60 and 65 parallel each other as both run the full length of Brookline Avenue between Kenmore Square and Washington Street (designated as State Highway Route 9) in Brookline Village. From there, Route 60 detours through a resi-

dential section before following Route 9 to Chestnut Hill in Newton. Route 65 turns to the northwest, following Washington Street through Brookline to Brighton Center.

Routes 60 and 65 provide less frequent service than Routes 47 and 66. Headways on Routes 60 and 65 are about 20 minutes during rush hours, about 30 minutes at midday, and about 30 minutes on Saturdays. Route 60 runs hourly on Sundays and half-hourly on weekday evenings, while Route 65 provides no evening or Sunday service and thus is not an option for second-shift and third-shift workers.

The ridership for a typical weekday evening peak hour 4:30 PM to 5:30 PM) for the routes serving the LMA was estimated based upon the survey return data. Ridership are listed in Table 17 and discussed below. As shown in the table there are an estimated 500 riders leaving BWH during a typical weekday peak hour. About two-thirds of the riders (322 persons) use the Arborway Line (E) or the Forest Hills Route 39 bus. The remaining one-third of the peak hour riders are dispersed among the other routes serving the LMA. It is interesting to note that none of the 181 patient-visitors interviewed over the two-day period indicated that they used transit. Finally, the 504 persons leaving BWH during the afternoon peak hour using transit represent about 6 percent of the capacity (8,780) servicing the area.

F. PEDESTRIANS

One of the issues identified early in the study process related to the volume of pedestrians and their relation to the other transportation characteristics of the area. The travel patterns presented earlier in the report identified the morning peak period all-walk trip at close to 13 percent. In addition, transit and vehicle trips (except ASB II and West Plaza parkers)

TABLE 17
MBTA ROUTES SERVING BWH
EVENING PEAK HOUR

Route	Destination	Headway	Planning Capacity*	BWH Staff*** Leaving	BWH Patients/ Visitors Leaving	Total Leaving BWH
E	Downtown (via Huntington Ave.)	8	1,950			
39	Copley	4	900	286	36	322
39	Forest Hills	4	900			
47	Andrew Square	17	210			
47	Cambridge	17	210			
47A	City Hospital	17	210	10	5	15
47A	Kenmore Square	17	210			
60	Chestnut Hill	18	200			
60	Kenmore Square	18	200	27	3	30
65	Brighton	25	145			
65	Kenmore Square	25	145	16	5	21
66	Allston	8	450			
66	Dudley Square	8	450	48	16	64
D**	Newton (Riverside)	6	2,600	46	6	52
Total			8,780	433	71	504

* Planning capacity is 60 passengers per bus and 260 passengers per streetcar.
** More than one-half mile from BWH.
*** Employees and physicians.

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require a walk component to get the individual to the hospital. Issues addressed include pedestrian volumes, travel patterns, and accessibility.

1. Pedestrian Volumes

Pedestrian counts were conducted at intersections in the vicinity of Brigham and Women's Hospital during the weeks of December 4, 1988 and December 11, 1988. The three locations are:

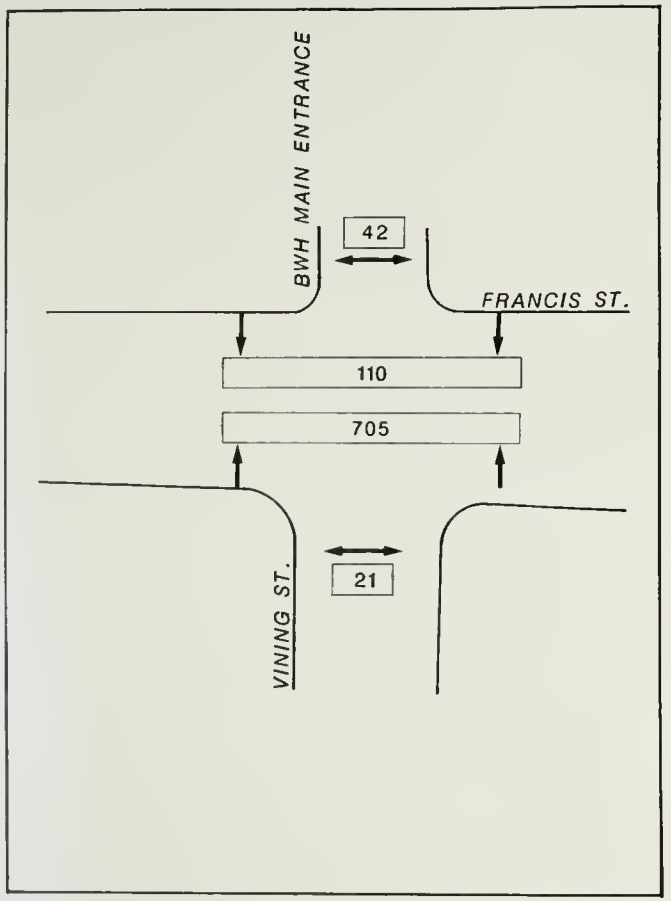
- Francis Street and Vining Street,
- Francis Street and St. Albans Road, and
- Brigham Circle (Francis Street and Huntington Avenue).

Counts conducted at Brigham Circle during the morning time period measured persons crossing Huntington Avenue to identify those persons crossing to and from the hospital. However, during the afternoon time period a comprehensive count was made to identify the crossing movements on all streets and all segments of Huntington Avenue (to the median MBTA stop, all the way across, and from the median MBTA stop).

These counts were conducted between 7:00 AM and 6:00 PM. Figures 15 and 16 present pedestrian count data for the morning peak period (7:00 to 9:00) for the three locations. The afternoon pedestrian volumes (12:00 noon to 6:00 PM) are presented in Figures 17 and 18 for the three locations. Evaluation of these data conclude that there are two peak hours; one during the morning and one during the afternoon. The morning peak hour at all three locations occurs between 7:45 and 8:45 (see Figures 19 and 20). The afternoon peak hour at intersections of Francis Street and Vining Street and Francis Street and St. Albans Road is between 2:45 PM and 3:45 PM (see Figure 21), while the afternoon peak at Brigham Circle is between 4:00 PM and 5:00 PM (see

Morning Peak Period Total Pedestrian Volumes (7:00–9:00)

Francis St./Vining St.



Francis St./St. Albans Rd.

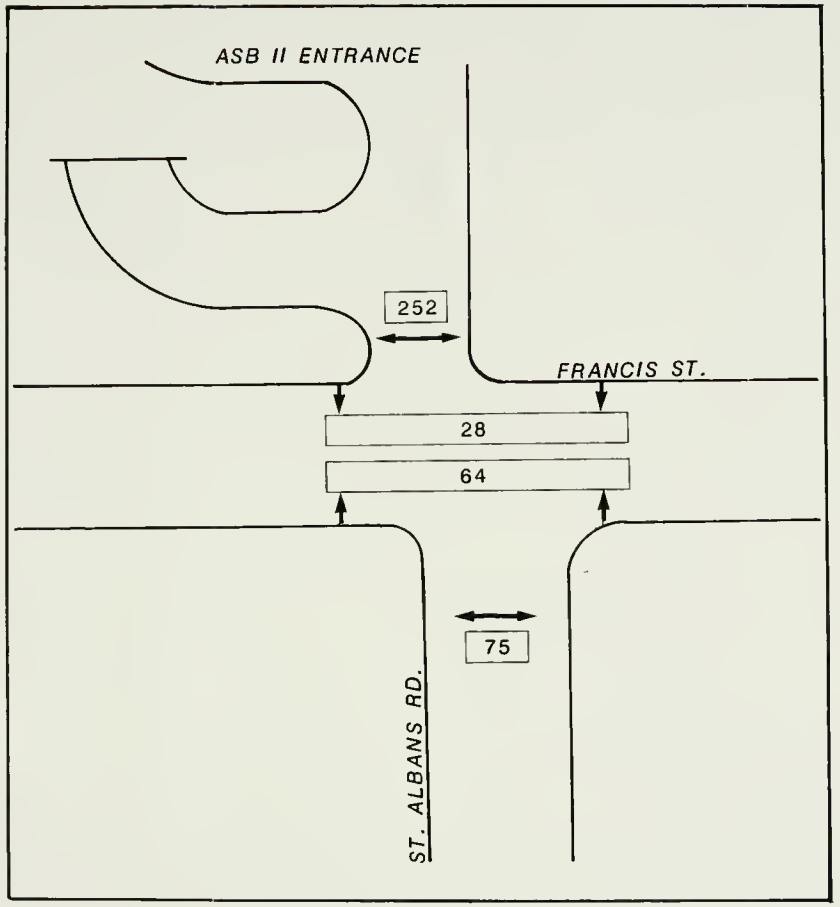


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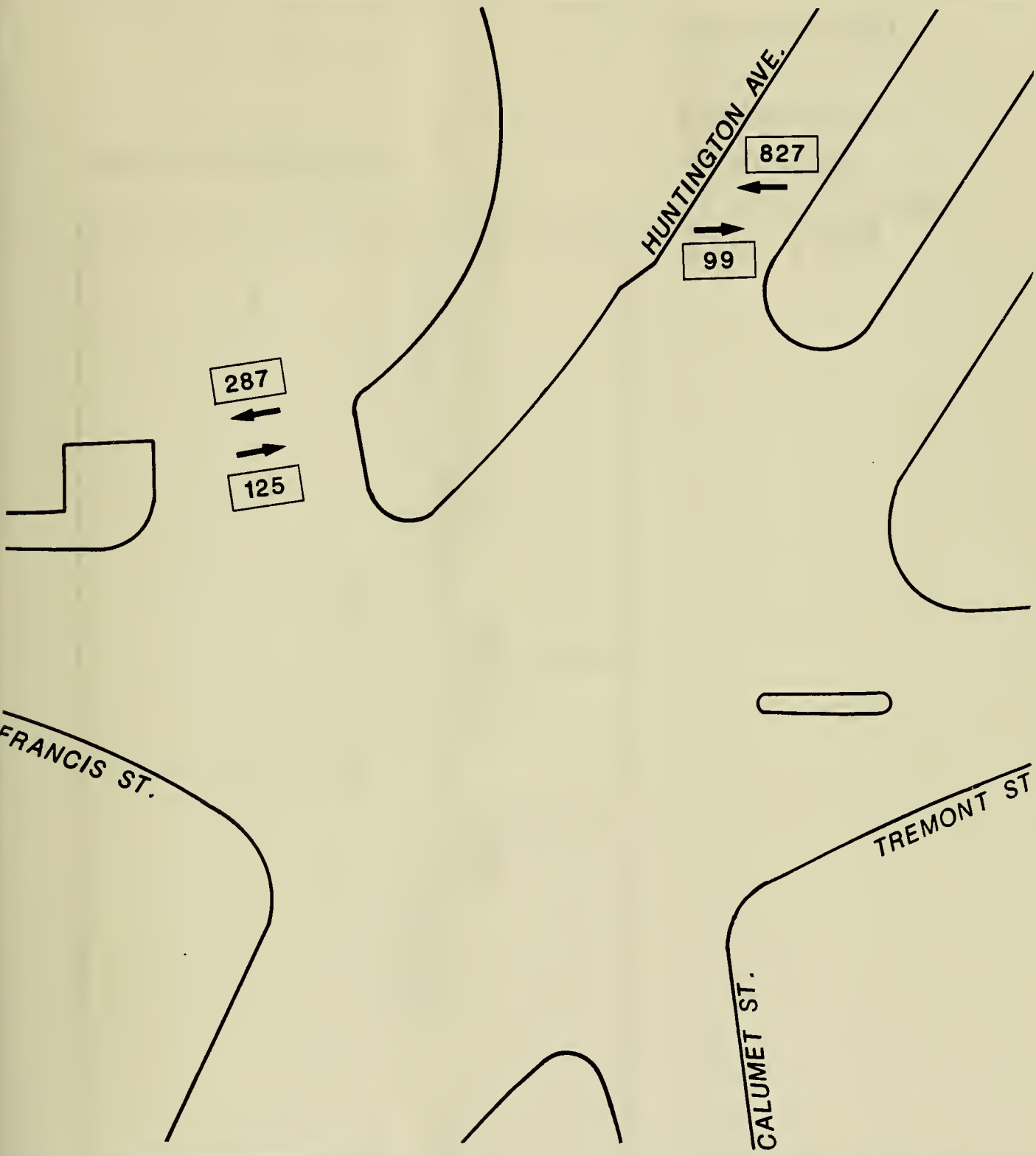
Fig. 15



Morning Peak Period Total Pedestrian Volumes (7:00–9:00) Brigham Circle

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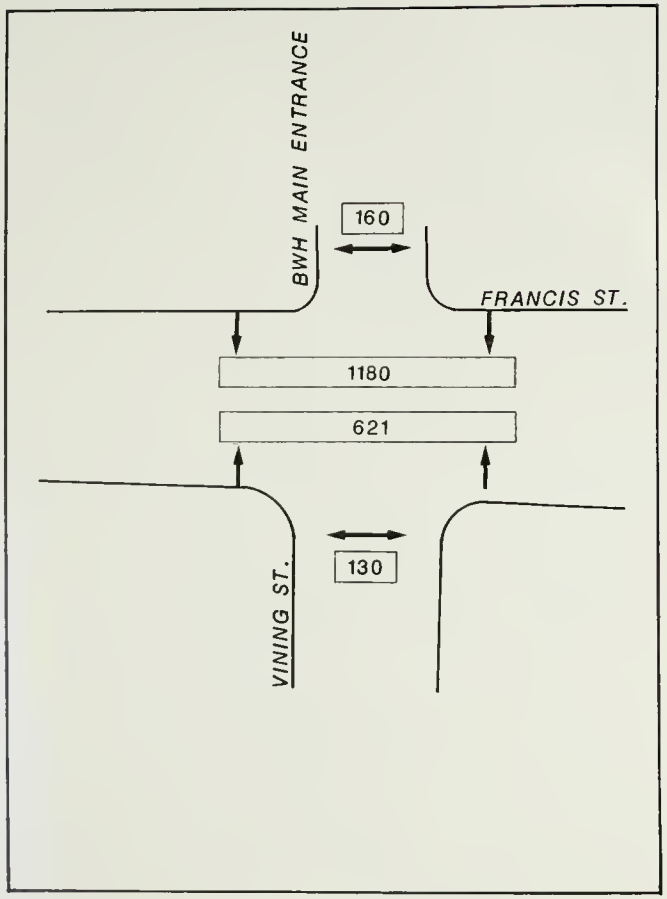
Fig. 16

Afternoon Total Pedestrian Volumes (12:00 Noon–6:00 PM)

Francis St./Vining St.



Francis St./St. Albans Rd.

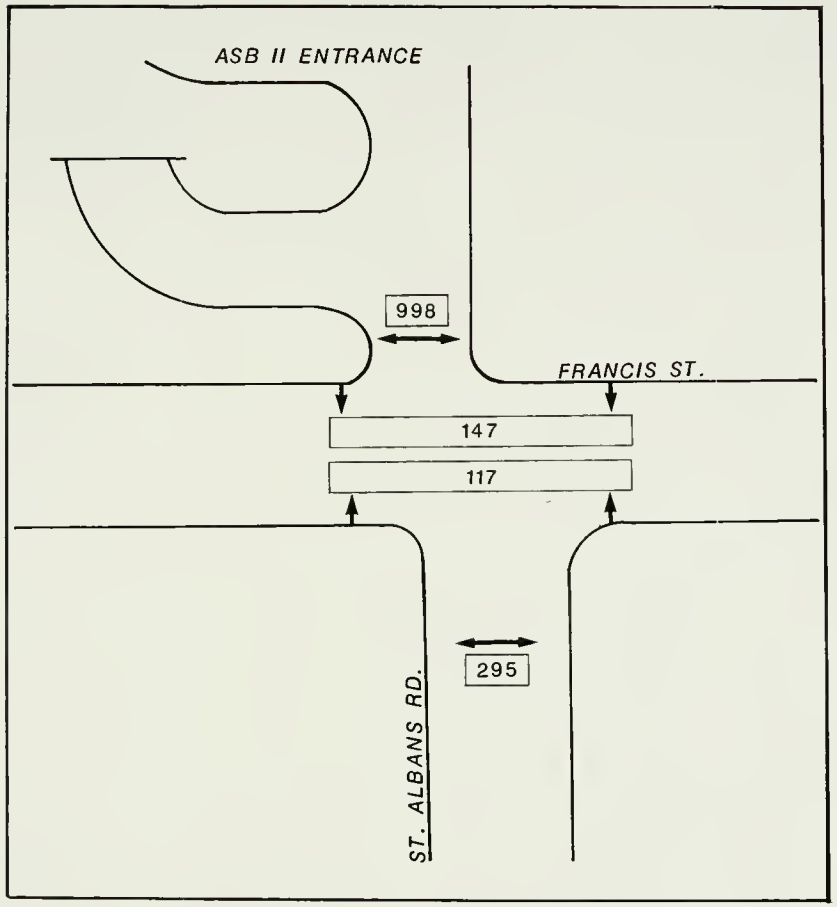


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Fig. 17

Afternoon Total Pedestrian Volumes (12:00 Noon–6:00 PM) Brigham Circle

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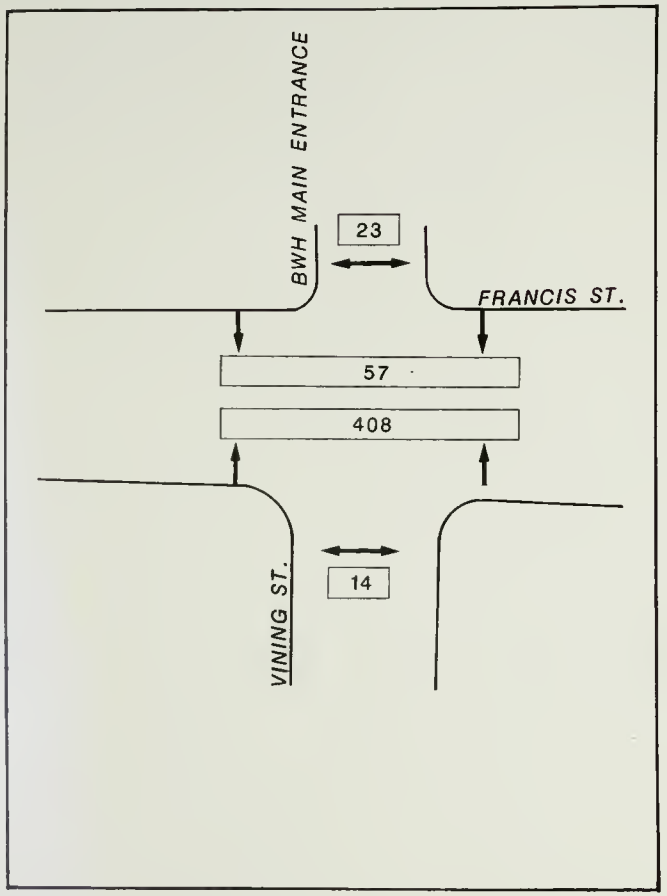
Fig. 18

Morning Peak Hour Pedestrian Volumes (7:45–8:45)

Francis St./Vining St.



Francis St./St. Albans Rd.

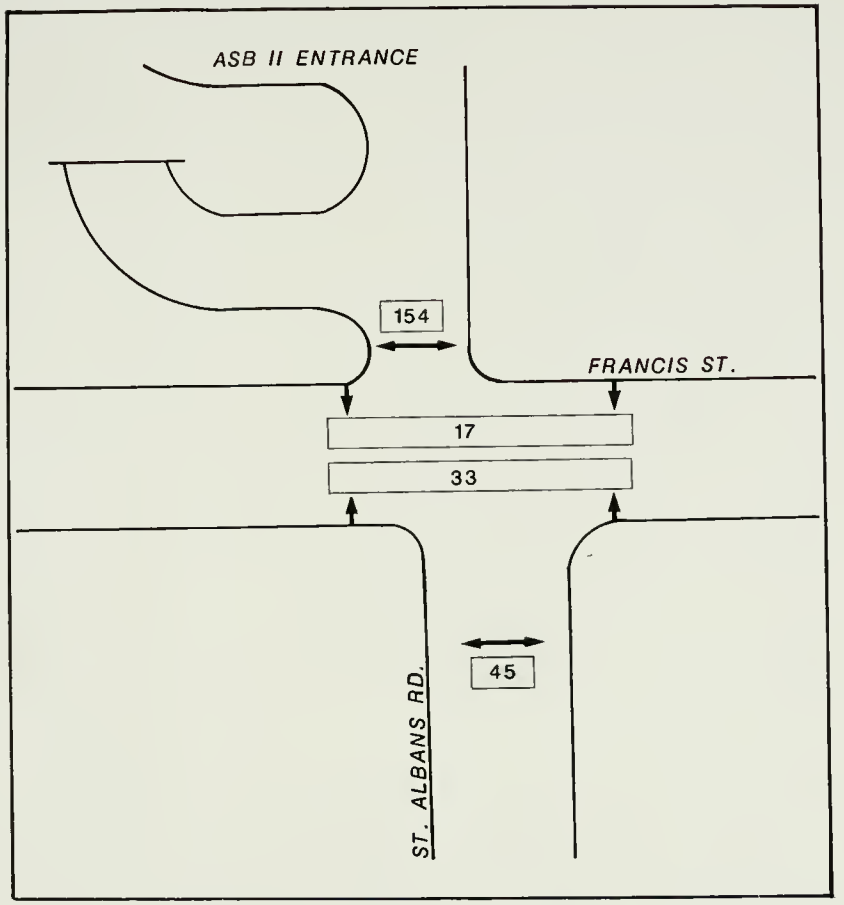


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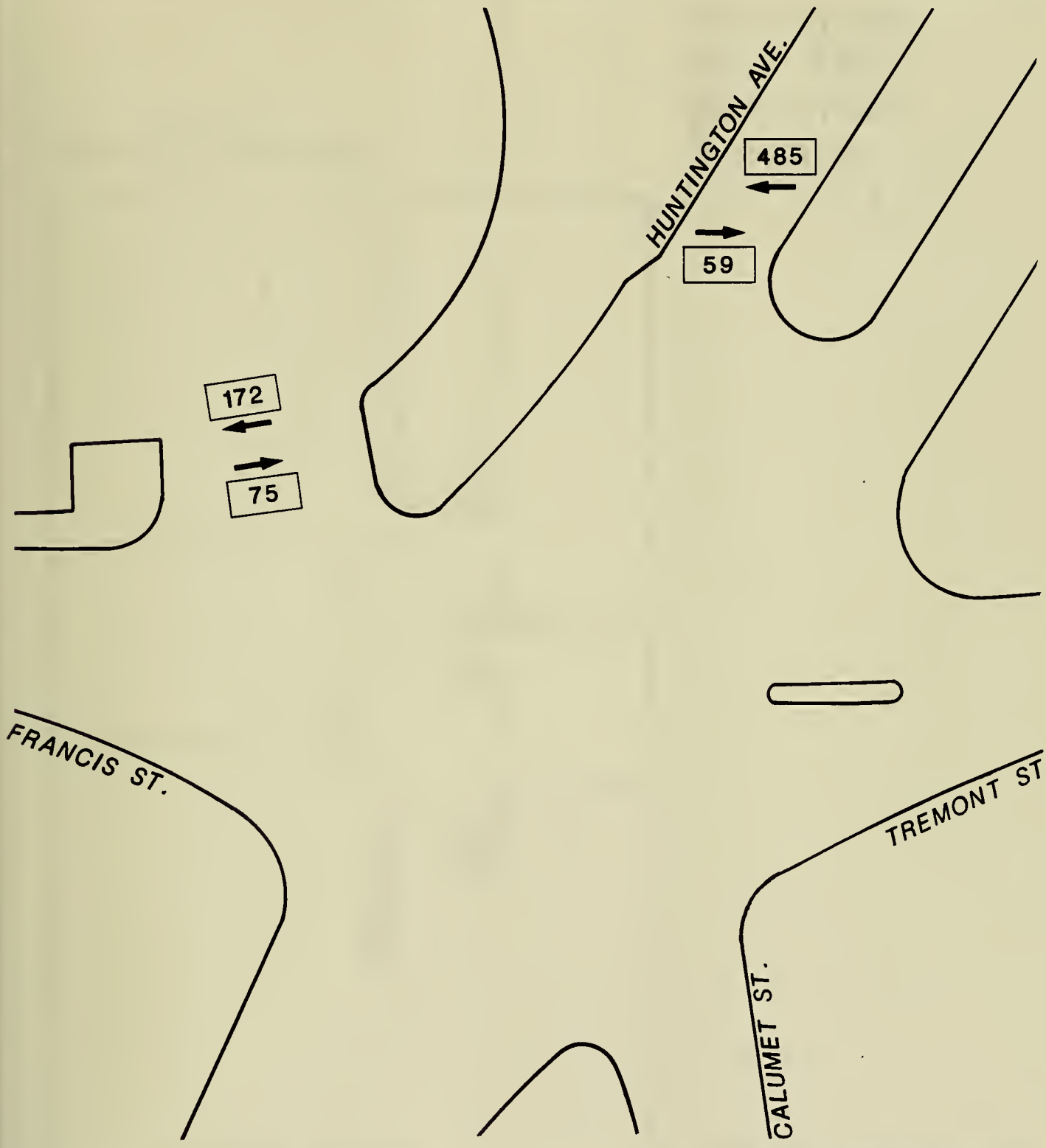
Fig. 19



Morning Peak Hour Pedestrian Volumes (7:45–8:45) Brigham Circle

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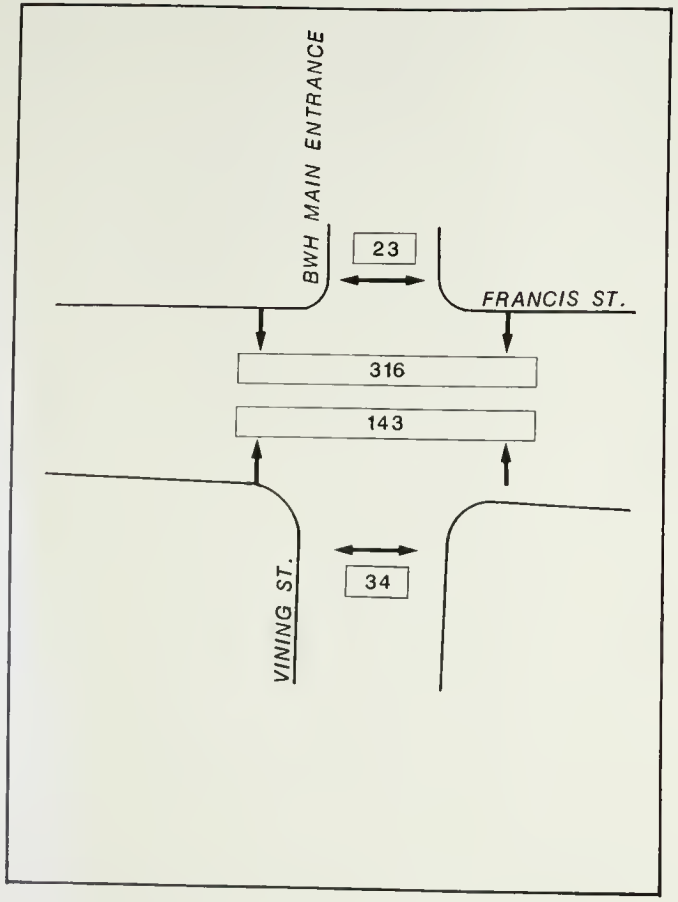
Fig. 20

Afternoon Peak Hour Pedestrian Volumes (2:45–3:45)

Francis St./Vining St.



Francis St./St. Albans Rd.

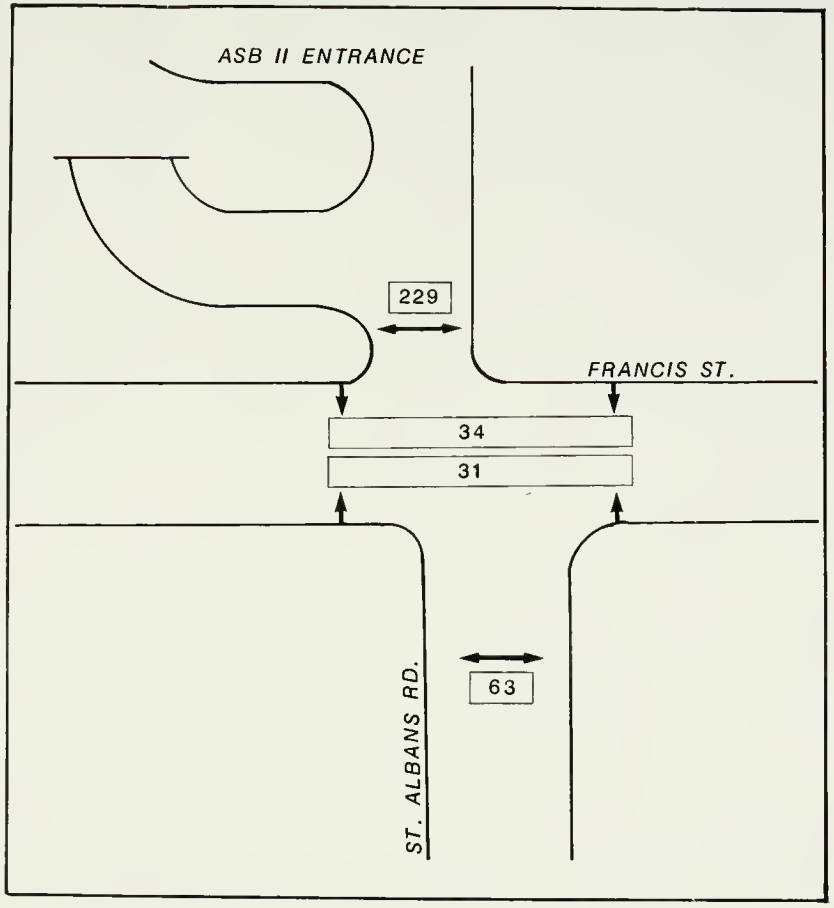


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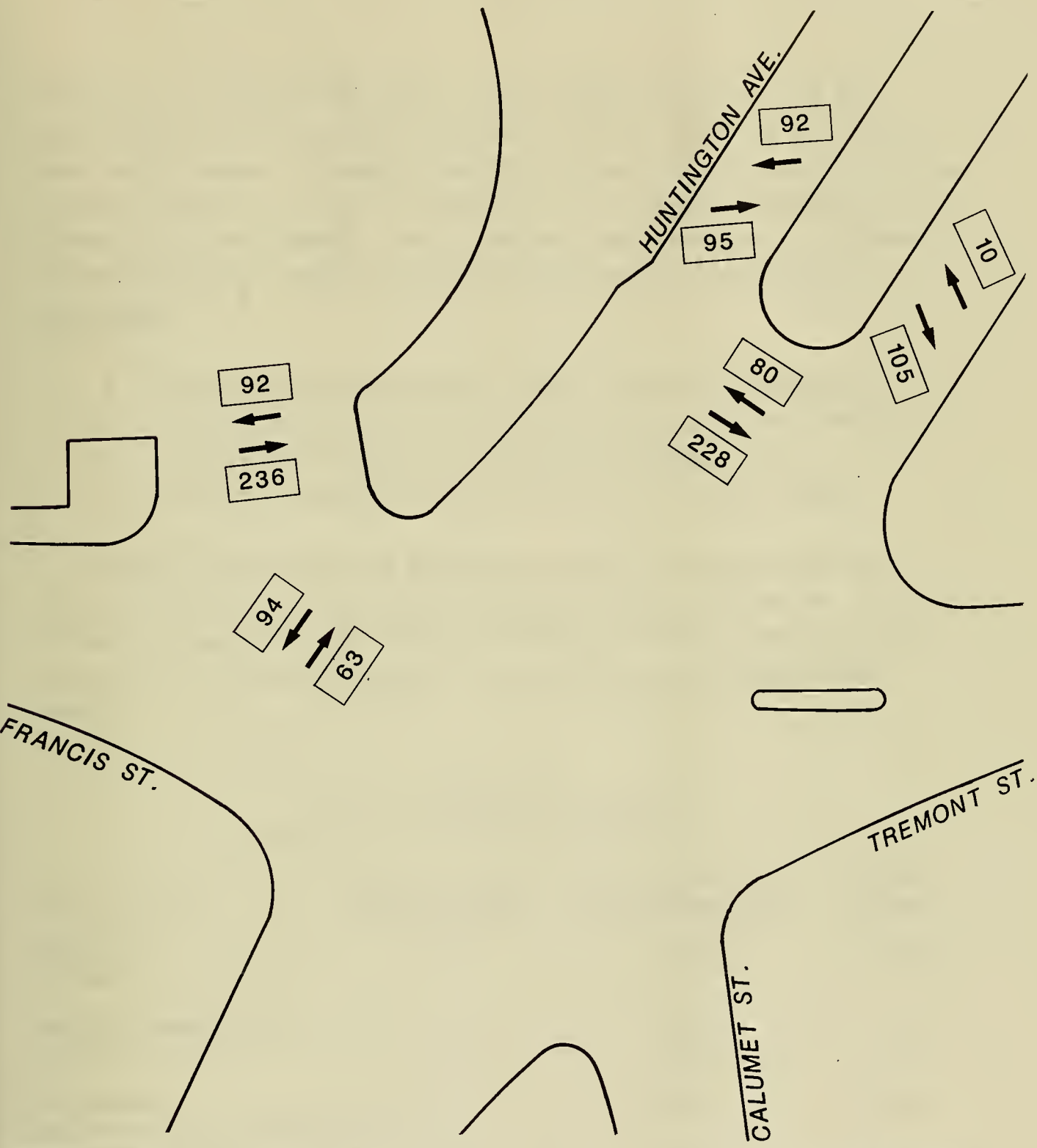
Fig. 21



Evening Peak Hour Pedestrian Volumes (4:00–5:00) Brigham Circle

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Fig. 22

Figure 22). This difference in afternoon peak hour can be attributed to the general commuter travel at Brigham Circle and the large number of hospital shift workers and patients who cross Francis Street at Vining Street or at St. Albans Road during the afternoon shift change. The movements presented in the graphics crossing Francis Street, Vining Street and St. Albans Road represent:

- Persons crossing Francis Street toward the hospital,
- Persons crossing Francis Street away from the hospital,
- Persons crossing the hospital driveways, and
- Persons crossing Vining Street or St. Albans Road.

Table 18 presents the total pedestrian crossings for the three locations by the reported time period. The number of individuals crossing at the Francis Street and Vining Street intersection is consistent between the morning and afternoon peak hours.

TABLE 18
TOTAL PEDESTRIAN CROSSINGS

Time Period	Francis Street/ Vining Street	Francis Street/ St. Albans Road	Brigham Circle
Morning (7:00 to 9:00)	878	419	1,338
Morning Peak Hour (7:45 to 8:45)	502	249	791
Afternoon (12:00 noon to 6:00 PM)	2,091	1,557	5,596
Afternoon Peak Hour* (2:45 to 3:45)	516	357	1,095

* The afternoon peak hour at Brigham Circle is between 4:00 PM and 5:00 PM.

Table 19 presents the number of individuals crossing Francis Street at the three locations.

TABLE 19
TOTAL PEDESTRIAN CROSSINGS - FRANCIS STREET

Time Period	Vining St.	St. Albans Rd.	Brigham Circle
Morning (7:00 to 9:00)	815	92	N/A
Morning Peak Hour (7:45 to 8:45)	465	50	N/A
Afternoon (12:00 noon to 6:00 PM)	1,801	264	940
Afternoon Peak Hour* (2:45 to 3:45)	459	65	157

* The afternoon peak hour at Brigham Circle is 4:00 to 5:00 PM.

Francis Street crossings are heaviest at Vining Street as might be expected since Vining Street serves as the travel path to the Mission Park Garage.

Crossing patterns at all three locations are heavier toward the hospital in the morning and away from the hospital in the afternoon and evening. Examination of Figure 22, which presents the evening peak hour pedestrian volumes at Brigham Circle, shows that the primary patterns are oriented away from the hospital. This area is a major public transportation stop and thus a great deal of pedestrian travel is oriented toward the Green Line.

2. Pedestrian Travel Patterns

At the request of the Boston Redevelopment Authority, BWH directed that an analysis of pedestrian travel patterns be conducted, to address the needs of community residents who may

wish to walk through the BWH campus to reach other destinations. As decided at a meeting between the hospital and the BRA, this analysis focused on the ASB II entrance to the hospital, located at the intersection of Francis Street and Saint Albans Road in the center of the residential neighborhood. To this end, a pedestrian survey was conducted on December 20, 1988, between noon and 4:00 PM. This time period was chosen to maximize the likely percentage of local residents interviewed. The questions addressed in this analysis are as follows:

- What portion of observed trips are cut-through trips (i.e., have neither origin nor destination at BWH)?

- What are the BWH and non-BWH destinations (origins) of pedestrian trips which begin (end) at nearby residences?

- What are the destinations (origins) of pedestrian trips which begin (end) at BWH?

The survey results are presented in Table 20, in which locations south of the observation point are given as column headings, while locations north of the observation point are given as row headings. As shown in the right-most column, 117 trips were surveyed, of which 102 began or ended at BWH and the remaining 15 were cut-through trips.

As indicated in the second column, 24 surveyed trips began or ended at a nearby residence, of which 15 were BWH trips while the remaining nine were cut-through trips. Of these nine, five began or ended at one of the three Harvard-affiliated schools in the area, and two began or ended at one of the two area high schools.

As shown in the first row of the table, 102 surveyed trips began or ended at BWH, of which 39 represented auto access trips, 29 were transit access trips, 33 were external walk trips, and one trip was internal to BWH (10 Vining Street is a BWH-leased office building).

To summarize, the vast majority of trips that passed through the hospital's ASB II entrance had a trip end at the hospital. The number of cut through trips was minimal.

TABLE 20*
PEDESTRIAN ORIGIN-DESTINATION SURVEY RESULTS

	Locations South of BWH					
	Parked Vehicle	Nearby Residence	Nearby Business/ Lunch Time Walk	10 Vining Street	MBTA	Total
BWH and Locations North						
Brigham & Women's Hospital	39	15	18	1	29	102
Longwood Avenue	1	1	0	0	0	2
Shattuck Street	1	0	0	0	0	1
Children's Hospital	0	1	1	0	0	2
Harvard (Medical, Dental, Public Health)	0	5	0	0	0	5
High Schools	0	2	0	0	3	5
Total	41	24	19	1	32	117

* Pedestrians were interviewed near the entrance to the ambulatory services building (ASB II).

3. Pedestrian Accessibility

The previous sections discussed and presented pedestrian volumes crossing Francis Street, at three primary intersections: Vining Street, St. Albans Road, and Brigham Circle, and pedestrian patterns identified from the origin-destination study.

This section discusses the physical characteristics of pathways used by pedestrians wishing to access the BWH either as:

- A destination,
- An internal trip, or
- A through trip.

The issues pertaining to these three categories are described below.

• Issues

For trips to or from BWH, the issue is how easily the campus is accessed from surrounding arterials (which carry transit service), and from area parking garages. For internal trips, the main issue is signage. For the last category, the goal is to accommodate pedestrians whose origins and destinations lie on opposite sides of the hospital. Although the number of cut-through trips is relatively small (see preceding section), VHB evaluated possible ways to accommodate these trips without unreasonably compromising the security needs of the hospital.

• Access Restrictions

Table 21 lists the hospital doors and indicates their restrictions and hours of operation. For the convenience of the general public, the hospital is basically an open campus from 6:00 AM until 6:00 PM daily, and unrestricted access to the

TABLE 21
PEDESTRIAN ACCESS POINTS

Location	North Side or South	Upper Level or Lower	General Entry Hours	Entry With Consent of Guard Hours	Key Card Entry Hours	Exit Hours
Tower Lobby	South	Lower	6AM-8PM	8PM-6AM	None	All
ASB I	South	Lower	6AM-6PM M-F	None	All	All
Tower Connector -- Front	South	Lower	6AM-6PM M-F	None	None	None
Tower Connector -- Rear	North	Lower	6AM-6PM M-F	None	None	None
ASB II Main	South	Upper	6AM-6PM M-F	None	All	All
ASB II Garage	South	Lower	5AM-11:30 PM Daily	None	None	None
Administration Lobby -- Front (Peter Bent Brigham)	South	Upper	6AM-8PM M-Sat	All shift changes	None	All
Administration Lobby -- Rear (Peter Bent Brigham)	North	Upper	6AM-6PM M-F	None	All	All
Thorn Building	North	Lower	None	6AM-6PM	All	All
West Plaza	North	Lower	7AM-6PM Daily	None	All	All
Emergency	North	Lower	None	All	None	All

entire hospital through the main entrances continues until the end of visiting hours at 8:00 PM. After that time, every entrance is either locked or attended. Hospital workers who come and go at controlled hours are issued key cards so that they will not be limited to the attended entrances. The front entrance to the Administration Lobby in the Peter Bent Brigham building, which is normally closed evenings and Sundays, is opened at each shift change to allow more convenient and safe access to public transportation on Huntington Avenue.

- Evaluation

Table 22 presents a qualitative evaluation of pedestrian routes, according to the following criteria:

- Barriers - physical or other impediments to pedestrian movement;
- Convenience - a general indicator of quality;
- Sight Lines - an indicator of how easily the pedestrian can see his destination and orient himself;
- Signs - the effectiveness of directional signs for pedestrians; and
- Security issues - including the hospital's need for a secure facility and the pedestrians' need to feel safe.

While the table presents more detail, a few items merit special attention. For example, the hospital has recently improved signs along the main east-west corridor known as the Pike. These signs direct pedestrians to the various clinics and offices. At the ASB II lobby, a directory helps patients locate their destinations.

TABLE 22
QUALITATIVE EVALUATION OF PEDESTRIAN ROUTES

Routes	Barriers	Convenience	Sight Lines	Signs	Security Issues
To BWH From					
Brookline Avenue	None	Good	Good	Adequate	Minor
Servicenter and Mission Park Garages	Francis Street	Good	Good	Adequate	Minor
ASB II Garage	Change of level*	Good	Poor	Poor**	Minor
Huntington Avenue (including MBTA)	Ramp up to Administration Lobby (Peter Bent Brigham)	Good	Good	Adequate	High Crime Area
Within BWH					
ASB II - Administration Lobby	None	Excellent	Good	Good	None
Tower - ASB II	Change of level*	Good	Poor	Poor**	None
Through BWH From					
Main Entrance or Tower Connector	"No Trespassing" signs; locked evenings and weekends	Good	Good	Poor**	No Guard Station
ASB II Entrance	Change of level*	Poor	None	None	Minor
Administration Lobby (Peter Bent Brigham) Entrance	Narrow outdoor stairs to/from back door; back door locked evenings and weekends	Good	Poor	Poor**	No guard station at back door

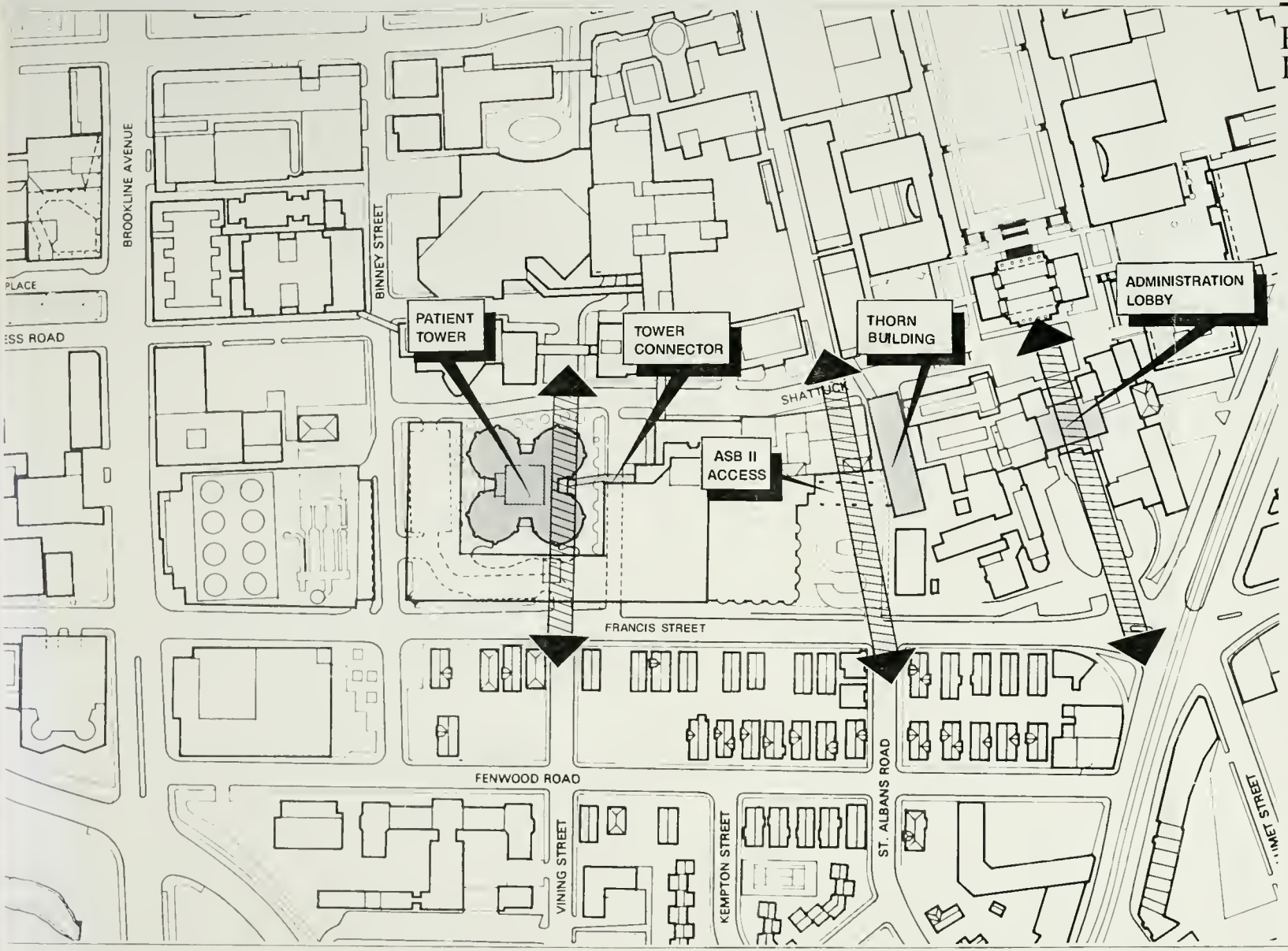
* These trips typically require pedestrians to ascend or descend one story because the main floor of one building is not at the same level as the main floor of the other.
** Observations were made prior to the completion of the BWH signage improvements.

The grade changes on the campus provide a challenge for both the designers and users of the hospital. The main entrance of the old Peter Bent Brigham Hospital (at the east end of BWH) is one story higher than the main entrance of the patient tower (at the west end of the campus). As a result, people walking from one main entrance to the other have to change levels. An attractive atrium staircase is provided in the Tower Connector for this purpose.

Similarly, it is difficult for pedestrians to travel north or south through the middle of the hospital (e.g., through the ASB II building) because the north doors are one story lower than the south doors. As indicated in the accompanying tables, north-south trips are more conveniently made through the Tower Connector toward the west side of the campus or through the Administration Lobby on the east side.

City officials have urged BWH to provide a public path through its campus. Three desire lines, illustrated in Figure 23, were identified by the BRA. Of these, the central route appears infeasible due to the grade change discussed above. The other two routes are already available during the day, but signage improvements would make them more accessible. To extend the hours of public access would require a guard station in the Tower Connector and some physical modifications at the Peter Lobby. Specifically, the hospital's assistant director of security suggested that installing a door to close off the stairwell near the rear entrance would channel all pedestrians from the rear entrance to the security desk in the Administration Lobby.

In conclusion, there is an extensive pedestrian system on the campus, designed to serve hospital users. Further improvements appear to be possible, which will make the system more convenient for hospital users and the general public.



Pedestrian Desire Lines

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Not to Scale

Fig. 23

able. Although this occurs in less than 3 percent of cases, several measures are being planned to improve the situation.

First, BWH is seeking to reduce the number of vendors from about 20 to about 5. This alone is likely to eliminate any capacity shortage and allow for future hospital growth.

Second, BWH will work with shippers (vendors) to improve delivery scheduling. If this effort is successful, deliveries will be scheduled for a specific hour instead of arriving any time between 7:00 AM and 3:30 PM. The reduction in the number of vendors will make it easier to implement the scheduling plan.

Because of the limited amount of warehousing space at the Servicenter, BWH is exploring the possibility of acquiring an off-site warehouse. If BWH is successful, the number of deliveries received at the Servicenter would be further reduced, because the same quantities would arrive at the Servicenter on fewer trucks.

Much of the trash handled by the hospital is the cardboard boxes in which supplies are delivered. To address the solid waste problem, BWH is committed to encouraging vendors to pack supplies in durable containers, which would be nested and returned for reuse.

2. Biomedical Sciences Research Building (BSRB)

The loading dock at the BSRB was designed to allow two trucks at a time to be loaded or unloaded. However, its capacity has been reduced by half due to the need to keep a trash container in the loading bay. There is insufficient room on the site for trucks to maneuver, so that trucks which need to use the loading

dock must back in from Shattuck Street. No tractor-trailer deliveries are accepted at the BSRB, and the majority of deliveries are made by vans.

Due to the preponderance of express and overnight services, most of the shipping and receiving activity at the BSRB occurs in the morning. About eight deliveries and pick ups occur on an average weekday. In addition, the solid waste contractor arrives once daily to pick up a full trash container and drop off an empty one.

Because of the concentration of morning deliveries, arriving truck and van drivers frequently find that the loading dock is fully occupied. In these cases, trucks requiring dock space must wait on Shattuck Street until space becomes available. Fortunately, Shattuck Street is a low-volume private way serving a local land-access function.

The shipping and receiving activity at the BSRB is related to the research activities occurring there. The loading bay capacity shortage is likely to be resolved when these research activities are relocated to the proposed Longwood Medical Research Center (LMRC) in the BLI complex at 221 Longwood Avenue as described below.

3. Boston Lying-In (BLI) Complex

No vendor deliveries are currently routed to the BLI complex. Instead, materials destined for the BLI complex are received at 89 Fenwood Road. BWH then shuttles the materials twice weekly to the BLI complex using its own small truck, which unloads outside the side entrance to the BLI complex. There is no dock at the BLI complex currently, but a dock will be added when the LMRC is built.

Deliveries at the BLI complex consist almost entirely of courier van deliveries, of which there are about five on an average weekday. The vans stop in the front courtyard, which has 24 parking spaces and adequate standing room to accommodate three or four vans at one time.

IMPACT OF PROJECTED DEVELOPMENT

The hospital's Institutional Master Plan, completed in late 1988, identifies the ten-year development program which projects the following:

- 30-60 new in-patient beds;
- 6 percent increase in in-patient activity;
- 17 percent increase in out-patient visits;
- 200 to 300 new jobs; and
- 104,000 square feet of net new research space.

This expansion of services proposed for the BWH will effect the hospital population, parking demand, and public transportation usage. This section presents those impacts.

A. POPULATION GROWTH

The hospital population includes: physicians, employees, patients, and visitors. It is estimated that these persons total about 10,000 individuals present at the hospital on a typical weekday. Estimated growth as represented in Table 23 would increase this population to about 10,963 over the ten-year period (9 percent). The physician category is expected to increase by 10 percent, while the employee category is expected to increase by only 7 percent. These growth rates were also used to calculate the projected parking demand and public transportation usage.

TABLE 23
HOSPITAL USAGE
PROJECTIONS

Category	Current Present On Typical Weekday	Growth Rate	Future Projected Typical Weekday	Percent Increase
Physicians				
Active Staff	365	1.06	387	
Fellows	488	1.06	517	
Researcher	268	1.34	359	
Resident	345	1.06	366	
Other	241	1.06	255	
Subtotal	1,707		1,884	10
Employees				
Management	390	1.04	406	
Reg. Nurse	1,117	1.05	1,173	
Licensed Prac. Nurse	69	1.05	72	
Non-Health Care Prof.	150	1.02	153	
Health Care Prof.	106	1.08	114	
Technician	504	1.06	534	
Patient Care Ass.	109	1.10	120	
Research Ass.	234	1.22	285	
Sec/Clerical	1,067	1.07	1,142	
Craft	67	1.06	71	
Support	490	1.09	534	
Subtotal	4,303		4,604	7
Contract Employees	119	1.00	119	0
Patients				
In-Patients	95	1.06	101	
Out-Patients	1,700	1.17	1,989	
	1,795		2,090	16
Visitors				
Patient Visitors	1,840	1.06	101	
Job Applicants	40	1.00	40	
Business	260	1.06	276	
	2,140		2,266	6
Total	10,064		10,963	9

B. PARKING

Again in this section, the parking demand discussion has been subdivided into hospital staff and patients and visitors.

1. Staff Parking

Table 24 presents the current and projected hourly parking demand for hospital staff. The projected peak demand is about 2,599 vehicles at 3:00 PM compared with 2,424 vehicles currently. This represents an increase of 7 percent over existing conditions. Similar to the current demand this peak extends to about 3:30 PM overlapping the day and evening nursing shifts. Assuming current patterns, the parking demand increase ranges from 11 vehicles during the late night hours to 175 vehicles at 3:00 PM. The overall pattern remains the same.

Since the time of the survey, the staff parking supply has been increased from 2,074 spaces to 2,304 spaces, a net increase of 230 spaces. In addition, it is assumed that 12 of the 24 spaces at the BLI complex, which are currently unavailable, will be available for staff parking when the Longwood Medical Research Center is completed. Including these spaces, the future staff parking supply is 2,316 spaces. The forecast peak hour parking deficit for staff is 283 spaces (2,599 minus 2,316). This represents a slight alleviation of the 350-space staff parking deficit, which existed at the time of the survey.

TABLE 24
HOSPITAL STAFF
ESTIMATED PARKING DEMAND
COMPARISON CURRENT VS. PROJECTED

Time	Demand		
	Current	Projected	Increase
6:00 AM	269	289	20
6:30	423	452	29
7:00	933	991	58
7:30	1,281	1,361	80
8:00	1,522	1,620	98
8:30	1,856	1,979	123
9:00	2,068	2,209	141
10:00	2,231	2,390	159
11:00	2,304	2,471	167
12:00 Noon	2,314	2,481	167
1:00 PM	2,302	2,469	167
2:00	2,292	2,459	167
3:00	2,424	2,599	175
3:30	2,397	2,570	173
4:00	2,126	2,283	157
5:00	1,730	1,859	129
5:30	1,377	1,481	104
6:00	1,196	1,286	90
7:00	908	973	65
8:00	578	616	38
8:30	474	505	31
9:00	448	476	28
9:30	411	436	25
12:00 Midnight	216	227	11

2. Patient and Visitor Parking

It is expected that the peak parking demand will occur at 11:00 AM and increase by 10 percent over the existing demand to 486 vehicles. As presented in Table 25, the increases are much smaller (7 to 44 vehicles) than those projected for the staff parking. While this number is about twice the number of spaces provided in the ASB II Garage, it is not a critical issue for two reasons: 1) demand reduction strategies would not likely be

successful; and, 2) there are other parking facilities in the area which are competitively priced for short-term visits and can accommodate the patients and visitors.

TABLE 25
PATIENT AND VISITOR ESTIMATED PARKING DEMAND
COMPARISON CURRENT VS. PROJECTED

	Demand		
Time	Current	Projected	Increase
8:00 AM	84	98	14
9:00	201	226	25
10:00	347	384	37
11:00	442	486	44
12:00 Noon	412	454	42
1:00 PM	399	438	39
2:00	379	412	33
3:00	345	373	28
4:00	206	226	20
5:00	159	169	10
6:00	114	121	7
7:00	242	257	13
8:00	340	360	20

3. Summary of Parking Demand

As shown in Table 26, the projected combined parking demand peaks at 3:00 PM with 2,972 vehicles. This represents a 7 percent (203 vehicles) increase over the current conditions. The 11:00 AM hour has a greater increase in demand with close to 8 percent (211 vehicles). The basic patterns remain the same.

TABLE 26
ESTIMATED HOSPITAL PARKING DEMAND
ALL USERS
COMPARISON CURRENT VS. PROJECTED

Time	Demand		
	Current	Projected	Increase
6:00 AM	N/A	N/A	N/A
7:00	N/A	N/A	N/A
8:00	1,606	1,718	112
9:00	2,269	2,435	166
10:00	2,578	2,774	196
11:00	2,746	2,957	211
12:00 Noon	2,726	2,935	209
1:00 PM	2,701	2,907	206
2:00	2,671	2,871	200
3:00	2,769	2,972	203
4:00	2,332	2,509	177
5:00	1,889	2,028	139
6:00	1,310	1,407	97
7:00	1,150	1,230	80
8:00	918	976	58
9:00	N/A	N/A	N/A
12:00 Midnight	N/A	N/A	N/A

N/A = Not available.

C. PUBLIC TRANSPORTATION USAGE

The overall afternoon peak hour public transportation usage is projected to increase by about 8 percent (from 504 riders to 545 riders) based upon the growth in the hospital user groups. The total projected usage of public transit is 545; 466 trips are attributed to staff and 79 trips are from patients or visitors. This estimate of future transit usage is about 6 percent of the capacity of the transit system serving the area.

D. SHIPPING AND RECEIVING SYSTEM

The modest growth in hospital activity outlined in the BWH Master Plan will have no negative impact on the shipping and receiving system, which currently operates acceptably. The

planned relocation of research activities to the Longwood Medical Research Center in the BLI complex, where a new loading dock will be constructed, is a positive step from the point of view of deliveries. The hospital's existing plans (discussed under existing conditions) to reduce the number of vendors, consolidate deliveries, and schedule deliveries for specific time periods will further improve the shipping and receiving system.

E. PEDESTRIAN SYSTEM

The changes proposed in the BWH Master Plan are expected to improve the pedestrian system. Demolition of outmoded facilities and consolidation of activities in appropriate structures will enable BWH to provide more open space and pedestrian amenities. The modest growth in pedestrian volumes associated with programmed growth is not expected to have any significant effect on the pedestrian system.

RECOMMENDED MANAGEMENT AND MITIGATION PLAN

A. INTRODUCTION

The preceding section of this report concluded that the forecast peak (3:00 PM) staff parking demand for 2,599 spaces is 283 spaces greater than the forecast supply of 2,316 BWH staff parking spaces in the horizon year of the Master Plan.

The recommended management and mitigation plan presented in this final section of the report consists of travel demand management strategies, traffic operations improvements, and other recommendations to support the programmed growth of the hospital.

B. DEMAND MANAGEMENT

To address the parking deficit forecast for the 10-year horizon, BWH does not plan to build additional parking supply. Instead, the hospital has embarked upon an aggressive program aimed at reducing the number of vehicles used for commuting to BWH. This demand reduction program, developed jointly by BWH and VHB, combines disincentives for driving alone, incentives and assistance for commuting by alternative modes, and publicity to make BWH staff aware of the alternative modes and the incentives provided. BWH is committed to this program and, in fact, has already begun to implement it.

1. Increase Parking Fees

Numerous studies have shown that parking fees are the most important factor in a commuter's decision whether or not to drive to work.[7] As shown in Figure 24, differences in parking fees are associated with sharp contrasts in the percentage of workers driving alone. Consistent with the recommendations of the Longwood Medical Area Transportation Study, BWH recently raised employee parking prices (by 14 percent) in the context of a plan which attempts to rationalize the parking system by charging the highest rates at the most conveniently located facilities (See Table 27).

2. Establish an LMA Parking Committee

Intense competition between LMA institutions for qualified employees makes it difficult for any one institution to make parking policy changes (e.g., price increases) which are unpalatable to its employees. A single parking policy, coordinated by the institutions as a unified effort, might be seen by employees as a rational, even if unpleasant, solution to a difficult problem.

Therefore, BWH will take the lead in the establishment of an LMA parking committee, which would be composed of the parking directors of the area hospitals. Such a group would share information regarding parking rates and act collectively in setting parking policies to achieve areawide transportation goals. Through such coordination, a portion of the funds saved through

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[7] Parking Subsidization and Travel Mode Choice - Southern California Rapid Transit District, Dr. Jesse A. Simon and Dr. Joel Woodhull, August, 1987.

Canadian Government discontinues free parking (1975)

Mode	Before	After	Vehicle-Trip Reduction
Drive Alone	34.9	27.5	
Carpool	10.5	10.4	19%
Transit	42.3	49.0	
Other	12.3	13.1	

1982 Mode Splits for two Downtown Los Angeles firms

	Commuter Computer			Control Company		
Mode	Free Parking (April)	Partial Subsidy (December)	Vehicle Trip Reduction	Free Parking (April)	Free Parking (December)	Vehicle Trip Increase
Drive Alone	48	21		38	41	
Carpool	18	43	29%	21	21	6.4%
Transit & Other	34	36		41	38	

Federal (Paid Parking) vs. County (Free Parking) employees (Los Angeles)

Mode	County	Federal	Vehicle-Trip Reduction
Drive Alone	72	40	
Carpool	16	27	34%
Transit	12	33	

1976 Survey of employees in Century City area of Los Angeles

Mode	Free Parking	Full Charge	Vehicle-Trip Reduction
Drive Alone	92	75	
Carpool	4	12	14%
Transit & Other	4	13	

Source: J. Simon and J. Woodhull. " Parking Subsidization and Travel Mode Choice". 1987.

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Parking Fee Impacts

Fig. 24

TABLE 27
PARKING RATE COMPARISON
EXISTING VS. PROPOSED

Facility	November 1988 Permit Holders	March 1989 Permit Holders	November 1988 Monthly Rate	March 1989 Monthly Rate	Percent Change
Nearby Facilities					
Servicenter Garage	177	202	$92 00	$99.00	8
Mission Park Garage	1,773	1,773	62.00	72.00	16
Peter Bent Brigham (Front)	9	14	92.00	99.00	8
Calumet Street Lot	55	55	85.00	91.00	7
Mass. College of Art (Longwood Avenue)	8	20	85.00	91.00	7
Vin/Fen #1	7	7	110.00	110.00	0
Shattuck Street Lot	19	19	92.00	99.00	8
Mass. College of Art (Huntington Avenue)	33	0	83.00	N/A*	N/A*
Remote Facilities					
#49 Landsdowne Street	0	70	N/A*	45.00	N/A*
Wentworth	170	170	36.00	45.00	25
Average Monthly Rate to Parker (Permit Holder)			63.87	72.67	14

* N/A = Not applicable.

parking subsidy reduction could be used to provide more cost-effective employee benefits, so as to improve the LMA institutions' ability to attract and retain qualified staff.

3. Preferential Parking For Vanpools and Carpools

Reserving the most convenient spaces for carpools and vanpools has proven an effective incentive for ridesharing, because the convenience of a choice parking spot is often sufficient to offset the inconvenience of sharing a ride. While differential pricing schemes are prone to abuse, preferential locations are self-enforcing because solo drivers are embarrassed to be seen parking routinely in carpool spaces. Accordingly, it is recommended that BWH designate carpool and vanpool spaces in the most convenient locations, for example, the West Plaza, the ASB II Garage, and the BLI complex courtyard. This recommendation will enhance the effectiveness of the parking price increases planned by the hospital.

4. Transit Subsidies for Employees

Transit subsidies, especially when combined with increased parking prices, can have a direct effect on mode choice. Children's Hospital, which recently instituted a 25 percent monthly transit pass subsidy on its pre-existing MBTA pass payroll deduction program, found that enrollment increased 60 percent as a result.

Employee transit subsidies are becoming increasingly prevalent. In the Longwood Medical Area, the Harvard Medical School and the New England Deaconess Hospital subsidize employee transit passes, and the Boston Transportation Department all but requires employee transit subsidies for new developments.

A subtle advantage of an employee transit subsidy program is that it may facilitate an appropriate reduction of parking subsidies. While parking price increases alone can control parking demand and meet transportation system objectives, total reliance on employee parking price increases may be misinterpreted as an under-handed pay cut. Because the transit pass subsidy is an employee fringe benefit, its inclusion in the plan makes clear that transportation management, not benefit reduction, is the objective.

BWH already sells MBTA passes at the cashier's office in the patient tower. The hospital is committed to implementing an MBTA pass subsidy for all its employees.

5. Areawide Ridesharing Coordination

The Medical Area Service Corporation (MASCO), which BWH supports through membership fees and assessments, operates a centralized ridesharing matching service with the assistance of the state-funded Caravan for Commuters, Inc. It is recommended that rideshare matching for the LMA continue to be handled centrally by MASCO, because the larger database of commuters increases the chances of successful carpools and vanpools.

The employee parking price increases planned by BWH will likely persuade many more Brigham employees to take advantage of the MASCO service. BWH will continue to devote the necessary resources to support ridesharing coordination.

6. Promotion of Alternatives to Driving Alone

The hospital will promote ridesharing and transit usage through articles in its weekly newsletter. BWH will also provide the MASCO brochure entitled "Commuting Alternatives to the LMA" to new employees.

Such a strategy might have a negligible impact by itself, but it could play an important supporting role in other traffic reduction programs. For example, a system of preferential parking for carpools would not be effective without a campaign to make commuters aware of the priority system.

7. Alternative Work Schedules

Alternative work schedules can reduce traffic congestion by spreading a given number of daily vehicle trips more evenly and reducing peak-hour volumes. In some cases, even total daily traffic volume can be reduced through programs that allow a given number of hours to be worked on longer shifts on fewer days. By allowing workers to adjust their commuting schedules, flexible work hours sometimes facilitate carpool formation.

Alternative work schedules already exist at BWH. Nurses' shifts not only have a variety of start times; they also have varying lengths. Physicians come and go as needed, and researchers set their own (often irregular) hours. Clerical employees work staggered hours as well.

The hospital is committed to flexibility in work schedules to meet its own objectives as well as those of the transportation system. The current shortage in many categories of critical staff necessitates a flexible approach to recruitment.

C. TRAFFIC OPERATIONS IMPROVEMENTS

Through its support of MASCO, BWH has sponsored an extensive study of traffic operations and transportation conditions in the Longwood Medical Area. That study recommended numerous improvements to the area's transportation system. So as not to dupli-

cate that effort, this study has focused on Francis Street, which provides primary access to BWH. Two improvements are recommended.

The primary improvement to traffic operations at BWH is likely to occur at the hospital main entrance opposite Vining Street. It is proposed to be relocated approximately 200-feet to the east on Francis Street. This adjustment would serve to: 1) reduce the pedestrian and vehicle conflict; and 2) increase the storage length in the West Plaza drop-off area, thus reducing the queuing onto Francis Street.

During peak hours of pedestrian activity, police control at the intersection of Francis Street and Vining Street should be considered. Traffic signals are not warranted[8] at this location; however, the pedestrian volumes are significant between 8:00 AM and 9:00 AM and again from about 2:30 PM to 5:30 PM.

D. OTHER RECOMMENDATIONS

1. Shipping and Receiving

It is recommended that BWH actively pursue its goals of scheduling deliveries for specific times and consolidating deliveries by reducing the number of its vendors. These goals are outlined in more detail in the existing conditions section of this report.

8 U.S. Department of Transportation, Manual on Uniform Traffic Control Devices, 1978.

2. Pedestrian System

It is further recommended that BWH and its architects work closely with the Boston Redevelopment Authority so that new buildings can be designed with an eye toward accommodating the pedestrian desire lines of the general public without compromising the security needs of the hospital. These issues are discussed in detail in the existing conditions section of this report.

E. CONCLUSION

In summary, the primary recommendation of this report is to address the projected staff parking deficit by reducing parking demand rather than by increasing supply. While BWH strongly supports MASCO's and the City of Boston's efforts to improve traffic flow in the Longwood Medical Area, the hospital is committed to doing its part to reduce vehicle-trip generation and encourage the use of alternative transportation modes.